ANNALS OF SURGERY

VOL. 111 MAY, 1940 No. 5

TRANSACTIONS

OF THE

SOUTHERN SURGICAL ASSOCIATION

MEETING HELD AT AUGUSTA, GA.

DECEMBER 5, 6, 7, 1939

ADDRESS OF THE PRESIDENT

THE SURGEON IN THE ROMANTIC STORY OF TEXAS*

ALBERT O. SINGLETON, M.D.

GALVESTON, TEXAS

PREVIOUS Presidential Addresses of this Association have been in the form of scientific papers, philosophic discussions on surgery as a science and profession, and those with a historic background. Most of you have witnessed my best efforts with a scientific paper, and I lack the ego and courage to venture my beliefs or views upon the problem of surgery as a whole; so I have taken the easiest course and will endeavor to give you some of the high lights of the romantic history of Texas, including its no less romantic surgical history.

In March, 1536, 400 years ago, a party of Spaniards from Mexico (New Spain), scouting in the wild lands near the Gulf of California, suddenly came upon a spectacle more strange and unexpected than the footprints which greeted Robinson Crusoe's eyes on his desert island. It was a white man, all but naked, his nakedness partly concealed by a tangle of long hair. He was accompanied by a Moor slave, Estebanico, two Spanish companions, Dorantes and Castello, and eleven Indians; his name was Álvar Nuñez Cabeza de Vaca (Fig. 1).

These were the survivors of a Spanish expedition of 600 men led by Narvaez, who, searching for gold, plunged into the Florida swamps in 1527, expecting to reach New Spain (Mexico) overland and by sea. But disaster rode their sails. Storms wrecked their ships, one of which was on an island off Matagorda Bay, on the coast of Texas, November 6, 1528. Indians

* Delivered at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

seized the shipwrecked Spaniards and made slaves of them. This was turning the tables with a vengeance, as a favorite practice of the Spanish conquistador was to enslave the Indians. These were the first white men to reach Texas soil, and the leader of the party, Cabeza de Vaca, became the first surgeon in Texas.

While slaves of the Indians, the tribe was visited by an epidemic disease of the bowels and half their number died. The Indians demanded that the white men stop the disease, and rather than lose his scalp, de Vaca accepted the medical degree. Magic, prayer, Indian medicine, cautery, cupping, herbs and concoctions obtained from the Indians were his remedies. Soon he and his companions were followed by a worshipful crowd of sick and crippled,

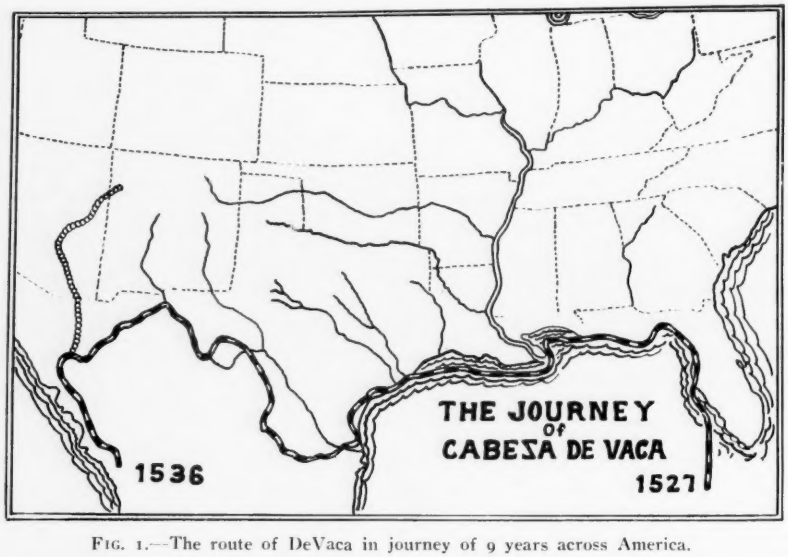


FIG. 1.—The route of DeVaca in journey of 9 years across America.

and in his story de Vaca tells of the many blind and diseased Indians he treated. He also describes an operation he performed in 1535: "Here they brought me a man, who, they said, a long time ago, wounded by an arrow, the point of the arrow above the heart. With a knife I carried, I opened the breast. I continued to cut and drew the head forth. With a deer bone I made two stitches and with the hair from a skin I stanched the flow of blood. The whole village came to look at the arrow. I cut the stitches and the Indian was well" (Fig. 2).

This was unquestionably the first surgical operation performed in Texas. It was 404 years ago and, at the same time, in the Old World, Vesalius was teaching anatomy and pointing out Galen's anatomic errors, and Leonardo da Vinci was painting the Mona Lisa. Also, Ambroïse Paré, with little more medical training than de Vaca, was making surgical history through the school of experience. With the passing of de Vaca across Texas, Spain claimed the country, though no white man remained.

THE FRENCH IN TEXAS.—One hundred fifty years later, this strange new

country was for all intents and purposes discovered again, and this time by a Frenchman. In 1685, Robert Caveliers de La Salle, one of the greatest of explorers, sailed down the Mississippi River to its mouth, laying claim to the great valley for France and calling it Louisiana (Fig. 3). One year later, on an uncharted sea, his ships missed their goal, which was the mouth of the Mississippi, striking the gulf coast at the west end of Galveston Island. A tropical storm wrecked the fleet on the same spot on which Cabeza de Vaca's Spaniards met disaster 150 years before. Disease and dissension arose among the stranded Frenchmen, and the great La Salle was murdered by some of his rebellious followers, led by his surgeon, Liotot, the second surgeon recorded in Texas. La Salle was troubled by a hernia but it was not operated upon.

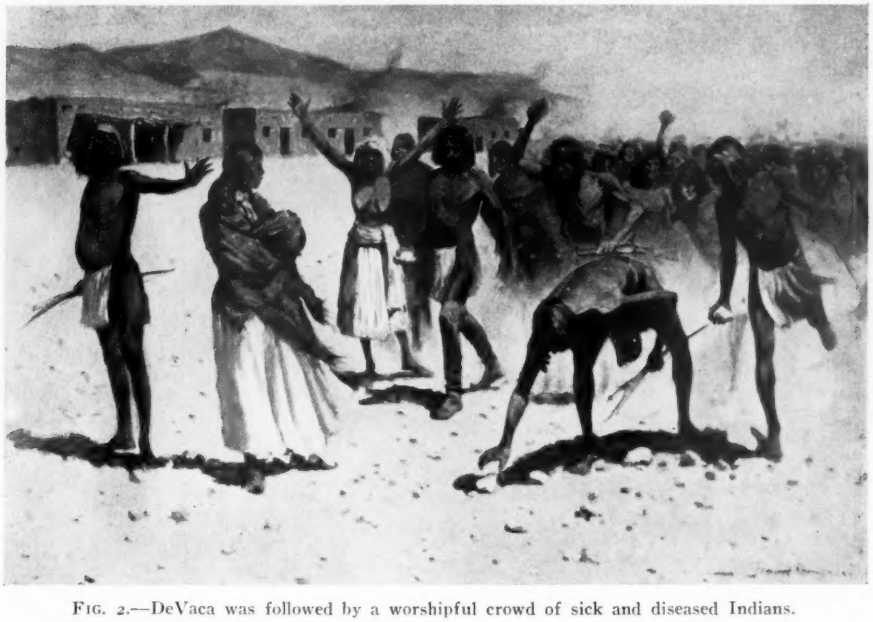


FIG. 2.—DeVaca was followed by a worshipful crowd of sick and diseased Indians.

Joutel, a priest, surviving the expedition says: "A soldier while retrieving a snipe shot in a marsh, was bitten on the leg by a rattlesnake. Five months later his leg still swelling, the surgeon, apprehensive of mortification, cut it off. But fever followed immediately and he lived but two days, dying on the Feast of the Decollation of St. John the Baptist, much lamented by all and particularly by Monsieur La Salle." This was the first amputation performed in Texas with a mortality of 100 per cent to the patient, and also the surgeon, who soon afterwards was assassinated. La Salle's expedition ended the first and only effort by France to colonize Texas.

SPANISH MISSIONS IN TEXAS.—Spain, fearing that the French would colonize the new country, sent an expedition, formed in Mexico, to settle here. This was in 1716, and in the next few years, many missions were established; the most famous of these was the historic Alamo (Fig. 4).

The missionary zeal of the padres was persistent but little headway could be made with the Indians. Only so long as corn and clothes were given them were they good Christians. Out on the plains roamed the fierce Comanches (Fig. 5) and Apaches, whose war cry brought terror to many white men, and the colonies did not prosper. The Spanish padre was filled with zeal for the salvation of the heathen souls, but nothing could speak more eloquently of the failure of Christianizing the Indian than the ruins of the Spanish missions, to be seen over Texas some 50 years later, and now.

La Salle's Landing in Texas

FIG. 3.

In 1762, following the French and Indian wars, rather than lose them to England, France secretly transferred all her claims to Texas and Louisiana to Spain, and Galvez, the young Spanish governor of Louisiana, became Governor of Texas as well.

At the turn of the century, Napoleon was flying high and in order to curry favor with him, Spain secretly transferred the Louisiana territory back to France. But Napoleon needed money more than wild Indians, and two years later, sold Louisiana to the United States. But Spain held on to Texas and though her claim was questioned, it was respected.

"The Spaniards were never quite happy in any part of the New World—where profit was to be had only as the reward of their own labor. They were

not natural colonizers and developers like the English, nor traders and diplomats like the French. They were conquerors, rulers and exploiters. They were never comfortable in the neighborhood of the hostile Indian because the Indian refused to be conquered."

The Coming of American Settlers.—The fertile plains of Texas were inviting to the Americans to the east and north who had begun to have growing pains after gaining their independence from England. Settlers began to sweep over the border and they were not the most peaceful settlers. In 1820, the Spanish authorities found it necessary to drive out a filibustering party under Dr. James Long, called by General Jackson at the Battle of New Orleans "my young lyon." In a battle with the Krankaway Indians on Galveston Island, his associate, Doctor Parnell, had his cap pinned to his scalp by an arrow. Lamar records that "the arrow was extricated from the scalp

Fig. 4.—Historic Alamo, 1716.

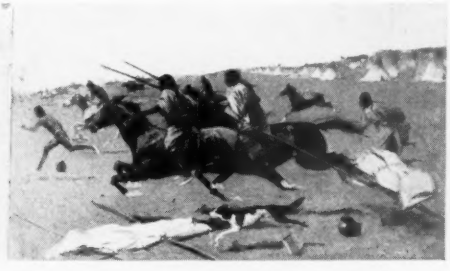


Fig. 5.—Fierce Comanche Indians (Remington).

'*secundum artem*' by Gen. Long with his broken sword." Thus another surgeon in Texas was not remembered for his scientific achievements. Also, the American buccaneer, Jean Lafitte, driven from New Orleans, had become established on Galveston Island from whence he was making war on Spanish ships. In spite of these events, Moses Austin was given a grant to settle 300 families. His 28-year-old son, Stephen, executed this first grant for settling Americans in Texas.

Stephen Austin was truly the Father of Texas, cultured, wise, persistent and faithful to his trust. Barker says of him: "He was successful with none of the tricks of the demagogue. His influence was based upon his recognized knowledge, wisdom and character."

In 1821, Mexico had gained her freedom from Spain, and in 1827, Santa Anna, an unprincipled leader, became President of Mexico. Considering himself the Napoleon of the West, he began to march into Texas to put down a rebellion of American settlers. Austin made haste to Mexico to intercede for the colonies but the only satisfaction he got was a year in prison. In 1835, he reached home to be followed by Santa Anna's army. The peaceful Austin now became aroused to the necessity for armed resistance, called the settlers together, declared their independence and declared war.

At this time there appeared upon the scene a man of destiny, Sam Houston, to continue his romantic exploits. "He had just come triumphantly

through a sensational affair in which he had bested the enemies of President Jackson in the U. S. Congress. For three years, ever since he had separated from his bride of only a few days and had resigned from the office of Governor of Tennessee, Houston had been under cloud." During this time he had lived with the Cherokee Indians on the Arkansas River, and he was regarded as, he has said of himself, "a man of broken fortune and blasted reputation." In 1830, he had come from his retirement and had endeavored, through President Jackson's influence, to help the Indians.

FIG. 6.—Fall of the Alamo, 1836.

Resenting an attack upon the President by Congressman Stonbury, of Ohio, he challenged him to a duel. Stonbury refused to duel, and upon being met by Houston on the street was thrashed with a cane. Houston was tried before the Bar of the House; the trial lasted a month and created a great sensation. Houston, referring to it, said: "I was dying out and had they taken me before the Justice of the Peace and fined me ten dollars for assault and battery, it would have killed me; but they gave me a national tribunal for a theatre, and that set me up again."

Houston, who was made Commander-in-Chief of the Texas Army, issued a call to arms October 8, 1835. Santa Anna's army was soon at San Antonio, and a hurried call was sent to Houston, 200 miles away, for help, but no help could reach San Antonio. The small garrison of Texans could have escaped, but a council of war between the leaders, Col. Travis, Col. Bowie and David Crockett, decided to defend the city. Gathering all within the Alamo, the old mission converted into a fort, with a few cattle for beef and a quantity of

corn, they prepared for a siege. A messenger slipped away with Travis' one last appeal addressed "To the People of Texas and All Americans in the World—Fellow Citizens and Compatriots: I am besieged by a thousand or more Mexicans under Santa Anna. I have sustained a continual bombardment and cannonade for 24 hours and have not lost a man. The enemy has demanded a surrender at discretion, otherwise the garrison are to be put to the sword, if the fort is taken. I have answered the demand with a cannon shot and our flag still waves proudly from the walls. *I shall never surrender or retreat.*"

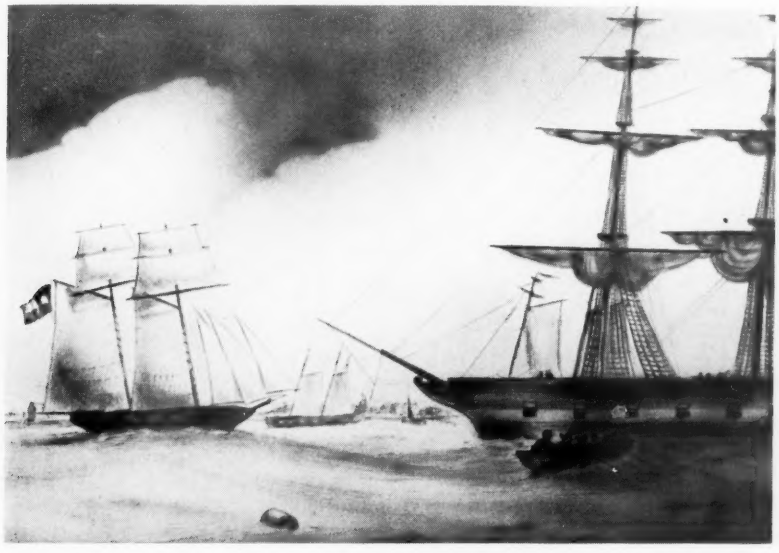


FIG. 7.—The Texas Navy, 1835.

For two weeks the little band of Texans held the fort against Santa Anna with an army grown to 4,000 men. On March 6, 1836, the fort was in ruins. The Mexicans forced the walls; Travis fell, shot through the head (Fig. 6). Bowie, who lay sick on a cot, raised himself up in bed, hurled his keen knife at the heart of the first man to face him and fell back dead. Davy Crockett was found with 20 dead Mexicans around him. Three women, a child and a Negro servant were all that fell into the hands of the victors. These were shot by order of Santa Anna. A commemorative tablet at the Alamo bears the legend: "Thermopylae had its messenger of defeat, the Alamo had none." One hundred eight-two Texans were buried in one grave. Fifteen hundred Mexicans were killed during the siege. A few days later, 400 men, at Goliad, under Col. Fannin, surrendered to a force of 600 Mexicans. Upon Santa Anna's order all were shot.

The martyrs of the Alamo and Goliad did not die in vain. The Mexicans had been held at San Antonio for two weeks during which time the settlers were fleeing eastward, and Houston was struggling to raise an army to meet the Mexicans.

On April 21, 1836, the Texas Army refused to retreat further and, with Houston's generals urging a stand, they prepared to fight an army twice their number. A surprise attack was launched by the Texans, which caught the Mexican Army completely off guard. It was early afternoon and Santa Anna and his men were taking an afternoon siesta, when the Texas Army charged with the battle-cry "*Remember the Alamo—Remember Goliad!*"

The battle was a one-sided slaughter—380 Mexicans were killed, 730 captured, some 40 escaped. Two Texans were killed and 20 wounded. In searching over the prairie for Mexicans the next day, Santa Anna, the Napoleon of the West, was brought in disguised as a private. The revolution had succeeded and the REPUBLIC OF TEXAS was born. The Battle of San Jacinto

FIG. 8.—Texas was occupied by three warring peoples.

was one of the 16 decisive battles of history, for here was settled forever the separation of the Latin and Anglo-Saxon races in the New World. The largest monument of its kind in the world marks the battlefield.

THE LONE STAR REPUBLIC AND THE TEXAS NAVY.—From 1836 to 1845, the Republic of Texas grew and prospered. For nine years it was a sovereign power, a power recognized by other powers, with her own constitution, army, navy, president and flag.

The Texas Navy was rapidly commissioned in 1835 to defend the gulf coast and prevent soldiers and supplies from reaching Santa Anna's Army as it traveled across Texas. The Texas fleet at the time consisted of the *Liberty*, a sloop of 80 tons, the *Independence*, 160 tons, the *Brutus*, 160 tons, and the *Invincible*, 180 tons (Fig. 7). They lived up to their high-sounding names, capturing many Mexican prizes, and successfully preventing support and supplies from reaching Santa Anna; and the little navy was unquestionably largely responsible for the victory of Sam Houston at San Jacinto.

The question of annexation was fiercely debated by Congress for several years because, if admitted to the Union, it would be another slave state, but President Polk signed the congressional bill, December 29, 1845, making Texas a State of the Union.

THE TEXAS RANGERS.—"The Texan was a transported American, an out-runner of the American frontier; they were intelligent, cool and calculating. In 1835, Texas was occupied by three warlike peoples (Fig. 8). The Indians held the undisputed possession of the Plains; the Mexicans held the Southwest, while the Anglo-Americans occupied the Central and Eastern portion. The *Texas Ranger* represented the Anglo-Americans in this conflict with the other two. They were small in number and in order to win they combined the fighting qualities of the three races." "A *Texas Ranger* could ride like a Mexican, trail like an Indian, shoot like a Tennessean, and fight like the devil."

For more than 100 years the Rangers have been the symbol of law in Texas. When the war began between the United States and Mexico, it was the rangers who led the way and won the Battle of Monterey for Zachary Taylor. General King, of Taylor's Staff, said of them: "Hays and his rangers were not only the eyes and ears of General Taylor's Army but his right and left arm as well." And when the going got bad with General Scott's troops from Vera Cruz to Mexico City, the Rangers were sent for. General Allen Hitchcock, of Scott's Staff, said of them: "Hays' Rangers have come, their appearance never to be forgotten, not any sort of uniform, but well-mounted and doubly well armed. Each man has one or two Colt revolvers, besides ordinary pistols, a sword and every man a rifle. The Mexicans are terribly afraid of them." There are many famous men recorded among the leaders, and many accounts are given of their daring and bravery, not only against Mexicans and Indians, but against outlaws, cattle thieves, train robbers and bank robbers. Captain Bill McDonald, who became a friend of Theodore Roosevelt, and the bodyguard of Woodrow Wilson, was a typical example of a ranger captain. When asked to explain his courage, he said: "No crook will stand up to a man when he is in the right, look him in the eye and keep on coming." On one occasion a riot, with many involved, caused the citizens of a Texas town to send hurriedly to the Governor for the Rangers. When the train arrived, only one ranger got off. He was met by an excited group who asked anxiously—"Where are the rest of the Rangers? We have a riot here." The Ranger quietly answered, "You ain't got but one riot, have you?"

THE TEXAS CATTLE AND THE TEXAS COWBOY.—These have been the source of almost as many romantic stories and songs as the Rangers. Before the railroads reached Texas, great herds of 10-, 20- and even 30,000 head of "long-horns" were driven in one drove to Kansas, Colorado and California. The "Chisholm Trail," the "Goodnight Trail" and others were famous routes made by the early pioneers. Goodnight was one of the greatest of cattlemen. He drove herds from Fort Worth to Denver. Because of the Comanche Indians in the North he blazed a trail west to the Pecos River and north on

the west side of the Pecos. Goodnight crossbred the buffalo and the Texas cow in an effort to develop a better beef. He was not a physician but a great animal doctor. His ingenuity was evident on many occasions. In the long constant drive over the desert he found that the bulls were unable to keep up with the herd because of swelling of the testicles from trauma. This condition he remedied by amputating the scrotum and sewing it up after pushing the testicles up into an undescended position. The same operation has since been employed by the urologists.

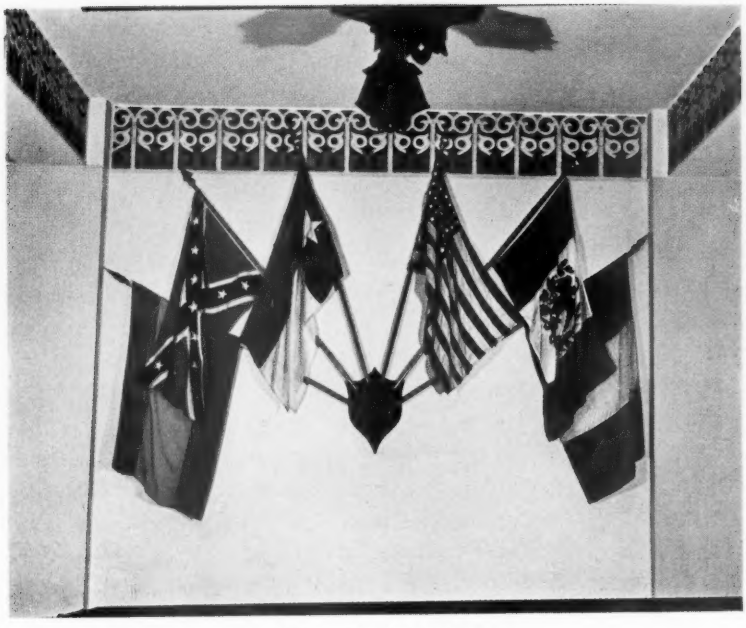
THE SURGEONS.—Our narrative has become so long that there is little time for the SURGEON in Texas. On the other hand, until more modern times he was of secondary importance. Medicine from the time of the Missions to the American colonization is recorded in the Spanish archives and also in the records in Mexico. It is recorded that the Indians suffered from disease and from many epidemics. The white man brought measles, smallpox, typhus fever, bubonic plague and influenza, and they took a terrible toll of the Indians. Syphilis, which supposedly was carried to Europe from the West Indies, probably was brought to the Texas Indian by the returning white man. The Indian medical man was wholly ignorant and though some herbs were used, generally, tricks and faking were his stock in trade.

Cabeza de Vaca's companion, the Moor, had already made medical history, for when he landed in Florida, in 1528, he came down with smallpox. The new world was virgin soil and many Indians died of the scourge during the next 300 years.

In 1798, Jenner discovered vaccination, and Charles IV of Spain, six years later, ordered that the vaccine be carried to Mexico and Texas. A ship with children aboard set sail. Two of the children were vaccinated each week with the virus taken from those vaccinated the previous week. Thus the virus was kept alive and brought from Spain to her possessions in the New World.

A most unusual Royal Decree from the King of Spain (found in Spanish archives) occurred in 1804. This was concerning the many spiritual and secular evils caused by not using the cesarean operation according to instructions. This Decree defined clearly the duties and obligations of those responsible for labor cases; and the rules prescribed by the College of Surgeons of San Carlos are included in the Royal Cedula. It provided that, in all towns, physicians should be on duty and be notified of the danger of death to patients in labor and every preparation made for a cesarean operation; and that they must not consent to the burial of anyone, regardless of class, dying of childbirth unless they knew that the operation had been performed upon her. This Decree was sent to all the colonies in Texas.

In San Antonio, the first Texas hospital was established in 1805, and it was in the famous Alamo, an abandoned mission building. We find that, in 1815, King Ferdinand VII of Spain sent an interesting document to his Texas Colony inquiring as to the number of hospital beds, and whether or not surgical and medical cases were kept separate, also as to whether the doctors called regularly; and many other questions and orders were set forth.



Texas under Six Flags.

Colonial Doctors.—During the colonial days we find records of epidemics of cholera, yellow fever and smallpox. There are also accounts of rattlesnake bites, but few accounts of surgeons of note. Austin's colonies were frequently without sufficient drugs and the services of physicians. The charlatan found a fertile field for martyrs but certain it is that Doctors Pollard and Michison, of Virginia, and Thompson, of North Carolina, achieved for the medical profession a portion of the glory of the Alamo where they died with their companions to whom they were administering to the end.

Attached to Fannin's command at Foliad were Drs. J. W. Shackelford and Joseph H. Barnard of the 400 Texans treacherously massacred. Doctors Shackelford and Bernard were spared that they might be utilized to treat the Mexican wounded.

A list of doctors who fought in the Battle of San Jacinto consists of 16. One of them, Dr. Anson Jones, played a very distinguished part in the making of Texas, and was called the "Architect of Annexation." He was the last President of the Republic of Texas. He was a descendant of Oliver Cromwell. Doctor Jones was born in Massachusetts and was graduated from Jefferson Medical College.

With a new country filled with adventurers one naturally would not expect a high scientific development among the profession, and unquestionably surgery was extremely crude. Texas naturally could not expect to develop her own surgeons, and we find that their importation came chiefly from the medical schools of Philadelphia, Louisville and a certain number from European countries. European surgeons who emigrated to Texas had had the best training. Browsing over the literature of this period, one is struck by the ignorance of some surgeons, and, on the contrary, by the ability of others.

In 1858, an account of the transfusion of blood for yellow fever is quoted: "The patient was a lady in whom the yellow fever had reached the usually fatal stage when hemorrhage takes place from the mouth. She would have soon expired from loss of blood in that way, when Dr. Benedict determined to try transfusion as a last recourse. The blood which he injected then, and afterwards, into her veins, he was careful to draw from the arm of a person (a volunteer) who had just recovered from yellow fever. This, we believe, is the only known case of transfusion in this city, but it is not likely to be the last. Indeed, it would not be surprising if that 'heroic' practice of phlebotomy (blood letting) was at a former period. It is obvious, however, that none but the most scientific and skillful should ever be suffered to undertake so delicate an operation." (Harrison Flagg, November 19, 1858.)

The Texas State Medical Association was organized in 1853, and a report of the Committee on Surgery, 1872, is remarkable in its completeness and the amount of work expended upon it. Dr. George Cupples, a brilliant surgeon, was Chairman of this Committee. The report sumarizes 4,293 operations, with a mortality of 8 per cent. Of the 2,080 major operations there was a mortality of 15.9 per cent. It is interesting to note that of these cases there were 38 secondary hemorrhages, with eight deaths, and 14 cases of

tetanus, following operation, with 12 deaths. Of the anesthetics which were employed in these operations, chloroform was in the lead with 3,178 cases, with one death before operation, no deaths during operation and alarming symptoms in only 12 patients. There were eight disarticulations at the hip joint, with a mortality of 50 per cent. There were 47 ligations of the arteries reported, among them being subclavian, axillary, brachial, common carotid, external iliac, common femoral and popliteal. Lithotomies in the male were 139, with a mortality of only 12 per cent, which, compared with the mortality in other operations reported, must have been more skillfully performed. Of these lithotomies, the lateral approach was employed in 81 cases, and the median in the remainder. The suprapubic operation was not practiced.

Many of the early surgeons deserve special mention, but time will permit of only a few: Dr. Ashbel Smith, a graduate of Yale, who came to Texas about the time of the Battle of San Jacinto, was a very close friend of Sam Houston, and was appointed Surgeon General of the Texas Army. His influence in the enactment of laws regulating the practice of medicine was needed and accepted. Also, he was the great spirit which caused the establishment of the University of Texas, and was Chairman of the first Board of Regents. He wrote upon many medical and surgical topics; he also became famous because of the assistance he gave as a collaborator of the American revised version of the Bible. He was Minister from the Texas Republic to the Court of St. James; he danced with Queen Victoria and lunched with Napoleon III. He spoke and wrote French easily, also Latin and Greek. At the beginning of the Civil War he raised the Second Texas Infantry and fought throughout the War. He was seriously wounded at the Battle of Shiloh.

Dr. George Cupples was probably the most outstanding surgeon in Texas at the time he lived. He was well educated, and never ceased in his endeavor to improve the condition of surgery. His father was Surgeon in the British Navy and he himself served as Assistant Surgeon in the British Army. He was graduated from the University of Edinburgh and studied extensively in London and Paris. He reached Texas about the time of the Mexican War and enlisted, serving throughout the War as a surgeon. He served as Senior Surgeon in the Seventh Texas Regiment during the War between the States.

Dr. Gideon Lincecum, a doctor-botanist, wrote extensively of Indian medicine. He paid a medicine man to teach him the art, spending many weeks with the Indians. Later he listed 500 plants in Texas with medicinal properties, many of which were used by the Indians. He wrote extensively and urged castration of criminals, as did many doctors of his acquaintance and some politicians.

Dr. Greenville Dowell, a graduate of Jefferson Medical College, was another pioneer of great force. In 1865, he was elected to the Chair of Anatomy in the First Texas Medical School at Galveston. He devised an operation for the radical cure of hernia. He also devised a subcutaneous ligature for the cure of varicose veins. His instruments for extracting arrowheads and bullets were favorably known to all surgeons in his part of the country. He

was more of a worker than a writer, but he found time to conduct the Galveston *Medical Journal*, a monthly journal that started in 1866 and ended in 1871. His writings upon yellow fever and malaria were valuable contributions. In an editorial in his medical journal he called attention to the hordes of mosquitoes preceding and accompanying yellow fever epidemics, ten years before Dr. Finlay, of Cuba, published his theory of mosquito transmission of the disease. He was called to the cities of Memphis and New Orleans for the yellow fever epidemics in 1870, and, in appreciation, was presented with a gold medal by each city. He was Surgeon in Charge of the Hospital Department of the Southern Army.

Berthold Ernest Hadra was born in Germany in 1842, and received his medical education in Breslay and Berlin. He held the Chair of Surgery in the old Texas Medical College, and his contributions to medical literature were numerous. He contributed to surgery of the spine by adding wiring of the spinous processes, which was probably the first effort ever made at internal fixation of the vertebrae for tuberculosis of the spine. My distinguished friend, Dr. A. C. Scott, makes the following interesting statement in regard to him: "Dr. Hadra performed nine Kraska operations for cancer of the rectum, and published his report of these cases. Dr. Nicholas Senn of Chicago became interested in Dr. Hadra's work and expressed a desire to have an interview with him. Accordingly, while in Texas, a visit to Dr. Hadra's office was arranged, and I had the pleasure of listening for about two hours to a detailed report of the cases. Dr. Hadra exhibited the pathologic specimens, each one of which was removed from the fruit jar in which it had been carefully preserved. There was much discussion between the two surgeons, part of which I could not understand because they often spoke in German, but I could tell that Dr. Senn was deeply interested and highly pleased with Dr. Hadra's work."

Dr. Ferdinand Herff, of San Antonio, who died at the age of 91, was born in Germany in 1820. Becoming dissatisfied with the political conditions of Germany, Doctor Herff led a colony to America. This colony formed the foundation for one of the most valuable citizenships Texas has had. He brought with him the culture and medical learning of Germany, which was far in advance of that of the New World. Doctor Herff's career in Texas was a long and remarkable one, and, in 1854, he performed his first noteworthy operation. It was a lateral lithotomy upon a Texas Ranger. It was the first time Doctor Herff had employed chloroform. The stertorous breathing of the patient, from the beginning of the operation, alarmed him to such an extent that the anesthesia was discontinued and the operation completed without an anesthetic. He performed his last operation at the age of 87 years. Probably no other surgeon in Texas can claim so many patients as he.

Dr. Bacon Saunders was a Past President of the Southern Surgical Association, and his activities were of such recent date, and his ability so well known to this organization, that it is unnecessary for me to mention his great influence in the surgery of Texas.

Doctor Saunders performed the first operation for appendicitis in Texas. This he did in a country home on a family dining table, his instruments sterilized on the kitchen stove. Wyeth's Surgery reports this as one of the first operations for appendicitis in the United States. I venture to say that Doctor Saunders did more heroic operations under similar circumstances than any surgeon Texas ever had.

Though a medical school had existed in Galveston since 1866, it was in 1891 that the University of Texas established a Medical Department. This was one year before Johns Hopkins Medical School was opened. A serious effort was made to secure an able faculty, and fortune smiled upon the effort, for among the small group of teachers were four youngsters, 28 to 30 years of age, who became professors of important subjects, and who were truly the four horsemen of Texas Medical education. With little to begin with except youth, enthusiasm and brilliant minds, they soon developed an efficient teaching institution which filled a crying need—for qualified doctors were scarce in the rapidly developing country.

Dr. Allen J. Smith, a graduate of the University of Pennsylvania, was selected as Professor of Pathology and Dean of the new school. In 1895, he discovered the ova of the hookworm and lived to see the inestimable benefits accruing therefrom to our Southern states.

Dr. Edward Randall was Professor of Therapeutics. He was a Texan and was educated at Washington and Lee, and was graduated in Medicine from the University of Pennsylvania. Two years were spent in study at Vienna, Berlin and Paris. He retired from the faculty after 40 years and since that time has been a member of the Board of Regents of the University of Texas. He was not only the perfect physician but for the 49 years of the school's existence his wise guiding hand has ever been at the controls.

The third member of the group was Dr. William Keiller, born in Midlothian, Scotland, and a graduate of Edinburgh, becoming a lecturer in anatomy in that institution. He was later made a Fellow of the Royal College of Surgeons. Beginning with no equpiment he developed one of the greatest anatomic teaching laboratories in America. He practiced surgery for quite a while but his soul was in anatomy, and for 40 years nothing could divert his interest. He wrote many theses on specialized anatomic subjects and published, in 1927, his book, Nerve Tracts of the Brain and Cord, which is considered a classic. He contributed 2,000 of his own anatomic drawings to the Anatomical Museum, which are invaluable aids in teaching.

The last name upon this roll of honor is that of Dr. James E. Thompson, a former President of the Southern Surgical Association. My close association with him as a student, and for 17 years as an associate in teaching, gives me the privilege of making more extensive comments, and I am sure because of his great life and enthusiasm for the Southern Surgical Association, you will be sympathetic and forgive me if I say too much.

He was born in Norwich, England. His studies in surgery were completed in the clinics and hospitals of Vienna and Paris. He filled the Chair of

Surgery in the University of Texas for 36 years. He was a fellow of the Royal College of Surgeons and a member of the American Surgical Association.

As an anatomist, embryologist, pathologist, teacher and skilled surgeon, he had no superiors and few equals. Especially notable was his work on The Surgical Approach to the Bones of the Extremities, which was reprinted by the United States Army for distribution to American surgeons during the World War. His articles upon cleft palate and harelip are classics in the literature of those subjects to-day.

He was a most interesting talker and his mind was a storehouse of knowledge ever open to his students, his assistants and colleagues seeking information pertaining to surgery in all its phases. He probably contributed his greatest good in the advancement of surgery in Texas and the Southwest. He was ever proud of the Southern Surgical Association and retained the highest admiration for its members, both collectively and individually.

I wish to acknowledge my dependence upon the following books for the story. I have drawn extensively from them, taking the liberty of quoting freely without giving direct reference to the authority. This is no doubt quite unpardonable. I am particularly appreciative of the assistance of my friend, Dr. Pat I. Nixon, from whose writings I have gotten valuable historic information. Also, I appreciate the privilege of reproducing Indian pictures from the Remington collection of Miss Ima and Mr. Michael Hogg.

REFERENCES

Nixon, P. I.: A Century of Medicine in San Antonio. 1936.

Idem: Liotot and Jalot, Two French Surgeons of Early Texas. Southwestern Historical Quarterly, July, 1939.

Roemer, F.: Texas. 1849. Translated by Mueller, 1935.

Bishop, Morris: Odyssey of Cabeza de Vaca. Century, 1933.

McSpadden, J. W.: Texas. 1927.

Barker, Eugene: Life of Stephen F. Austin. 1933.

Webb, W. P.: The Texas Rangers. 1935.

Molyneaux, Peter: The Romantic Story of Texas. 1936.

Red, G. P.: The Medicine Man in Texas. 1930.

Idem: The Texas Navy.

Stuck, W. G.: Alvar Nunez Cabeza de Vaca, 1490–1564, First European Physician and Surgeon in the United States. Texas State Med. Jour., May, 1936.

Chapman, Arthur: "Out Where the West Begins"—From Songs of the Cattle Trail and Cow Camp. John A. Lomax. The Macmillan Co., 1931.

THE PRESENT STATUS OF THE "RADICAL OPERATION" FOR CARCINOMA OF THE BREAST*

BARNEY BROOKS, M.D., AND ROLLIN A. DANIEL, JR., M.D.

NASHVILLE, TENN.

FROM THE DEPARTMENT OF SURGERY, VANDERBILT UNIVERSITY SCHOOL OF MEDICINE, NASHVILLE, TENN.

THERE has arisen, particularly during the past 10 years, a difference of opinion as to the effectiveness of the operative treatment for carcinoma of the breast. Objections to the routine employment of the "Halsted operation" have come from representatives of surgical clinics so influential that they cannot be disregarded. It has been stated that removal of the primary tumor with only a portion of the mammary gland gives as good results as the "radical operation." It has also been stated that treatment by radiation alone results in survival periods equal to those observed after the Halsted operation. Mitchiner, Bailey and Price[1] have recently analyzed the results of all of the operations for carcinoma of the breast in St. Thomas's Hospital (London) performed during a period of 20 years. Approximately one-fourth of these operations were limited to local excision of the primary tumor. After comparing the results obtained from the employment of the "Halsted" operation and the most conservative operations, these authors made the following statement:

"As a result of 20 years' figures on the cases of carcinoma of the breast operated upon in this hospital, it has been found that the mortality is practically the same whether the Halsted operation or the more conservative removal of the breast has been performed. It is urged in this article that the conservative and much less mutilating operation should be much more generally adopted in all cases of carcinoma of the breast."

During the 1937 meeting of the American Surgical Association, Geoffrey Keynes[2] presented the results he had obtained by the treatment of carcinoma of the breast by interstitial radiation. The survival periods of this series of cases compared favorably with any previous report of the results obtained by operation. Keynes' opinion of the effectiveness of the routine employment of the radical operation is presumably emphasized in his following recommendations, which I believe are contrary to the opinions generally held by American surgeons:

(1) Local removal of the tumor if it is large, or the diagnosis is uncertain, followed by radium.
(2) Local removal of the breast if the tumor is very bulky, followed by radium.
(3) Never dissect the axilla.
(4) Radium by itself may be used: (a) If the tumor is of moderate size and the diagnosis certain; (b) if the patient refuses operation.

* Read before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

The possibility of different results being obtained by the American and the English surgeons from the employment of the Halsted operation, because of the existence of different ideas in the two countries of the technic of the operation, is suggested by a recent publication of Ogilvie.[3] From his observations of the methods employed in several American surgical clinics, Ogilvie pointed out certain differences in American and English surgery and particularly emphasized the different technics employed in the radical operation for carcinoma of the breast by making the following statement:

"I watched several dyed-in-the-wool Halstedians performing the radical amputation of the breast, and I felt that here the knife ideal, carried to its extreme, is the 'letter that killeth.' A dissection of the axilla with a knife is distressing to watch; the surgeon takes more than an hour to do part of the operation for which we should need ten minutes."

Ogilvie apparently believed that the sole purpose of the American Halstedian operation in the employment of the painstaking and time-consuming technic in the removal of the axillary contents was to secure the most perfect healing of the wound. The idea that the particular technic employed might increase the chance of complete removal of the disease was apparently not appreciated.

Besides the great difference in the technic employed by Mr. Ogilvie's "dyed-in-the-wool Halstedians" and those surgeons performing one-fourth of the operations in St. Thomas's Hospital, there also exist varying degrees of lesser differences in technic employed by surgeons performing the operations considered as standard in one country or even in one hospital. The radical operation for carcinoma of the breast is founded on a principle which makes it obligatory to assume that even a small difference in the technic would frequently produce a total difference in the result obtained. Any report, therefore, of the results obtained from the employment of any operative procedure for the cure of carcinoma of the breast, to be of value, must be based on experience in which there is in each individual case no doubt of the reality of the disease, a careful study of its demonstrable extent and the employment of a uniform operative technic. The purpose of this paper is to call attention to the fact that the value of operative treatment of the breast is now being questioned without sufficient analysis of the varying technics employed, and to report the results in a series of cases having the same operation and one which we believe conforms to the basic principles of the radical operation.

The radical operation for carcinoma of the breast may be defined as an operative procedure which, with due regard to operative mortality and permanent mutilation, removes in one mass all of the structures which are liable to immediate invasion by tumor. Operative mortality and permanent mutilations are important in determining the desirability of performing operations so extensive as to include a part of the chest wall or even a shoulder girdle, but differences of opinion or differences in appreciation of the importance of removal of structures liable to immediate invasion by the tumor are for the most part responsible for variations in the technic of the radical or Halsted operation as usually understood.

The importance of the phrase "one piece" in the definition of the radical operation for carcinoma of the breast cannot be overemphasized. In other words, the purpose of the operation is not the excision of the breast, pectoral muscle and axillary contents, but the extirpation of a single block of tissue so large as to include not only these structures, but all of the intervening and as much as possible of the surrounding tissues. The failure to appreciate this principle results, even where very extensive operations are performed, in piece-meal removal, or the separation of structures by tearing, thus leaving behind structures liable to be invaded by tumor.

The idea of wide *en bloc* excision of structures for the cure of carcinoma of the breast is founded on a conception of the mechanics of the regional spread of the primary tumor. This operative procedure assumes that at least in the structures which it is possible to extirpate in one mass, the tumor spreads from the original focus by continuous permeation in all directions, and that there is presumably a continuity of tumor between the primary growth and a circumference well outside the limits of visible tumor tissue. It is recognized that the rate of spread is different in different directions because of the ease of permeation in the direction of the course of many large lymph channels or the resistance of thick sheets of fascia not penetrated by lymphatic channels.

Regardless of the correctness of this theory, it, nevertheless, remains true that the radical operation for carcinoma of the breast as previously defined cannot be justified on any other theory of the mechanism of the spread of cancer originating in the mammary gland.

Mr. Charles Moore,[4] in 1867, made the first clear-cut statement of the fundamental principles and purpose of the operation intended for the cure of carcinoma of the mammary gland. From observations of local recurrence after operations for cancer of the breast, Moore called attention to the frequency with which inadequate operation was performed and makes the following significant statements:

(1) Recurrence of cancer of the breast is due to a local condition not belonging to structures out of continuity with the first tumor.
(2) Centrifugal dispersion determines the recurrence of cancer.
(3) Cancer of the breast requires the careful extirpation of the entire organ.
(4) Besides the breast, unsound adjoining structures, especially the skin, should be removed in the same mass with the principal disease.

At the time these statements were made by Moore, the point at issue was whether secondary implantations of cancer of the breast were extensions from a single focus of origin or whether they represented other manifestations of general systemic disease (cancer diathesis). After it was no longer a question of cancer originating at a single focus, Handley arrived at almost exactly the same conclusion from a study of the relative importance of the two methods of extension of the malignant disease, *i.e.*, by permeation or by embolism. It is interesting to note that there is no difference in the foundation for the

radical operation for carcinoma of the breast because of the change of concept from that at the time of Moore to that at the time of Handley. It is also worth while to point out that in view of the conditions under which surgery was performed during the time of Moore, his recommendations met all of the requirements of the previous definition for radical operation for carcinoma of the breast.

After the institution of aseptic methods, surgeons not only began the employment of new operative procedures, but were also able to extend the limits of operations long previously undertaken. Thus in operations for carcinoma of the breast, Volkmann, Gross, Haidenhain, Kuster and others extended the operation to include the removal of the major pectoral muscle and axillary lymph nodes until the approximate limits of the present day operation were reached by Halsted[6] and Willy Meyer, in 1894. The remarkable similarity in technic of these two surgeons and more particularly the phrases employed in the statement of fundamental principles involved, even to the use of italics, is definite evidence of there being a common source of the ideas expressed in these two almost simultaneous publications. The larger experience of Halsted at the time of his publication, and particularly the continued interest on the part of Halsted for many years previous and subsequent to the appearance of his description, justly entitle him to great credit for the development of the method which has, until comparatively recently, been considered throughout the world as the standard treatment for the cure of cancer of the breast.

In a paper entitled "The Blood Clot in the Management of Dead Spaces in the Treatment of Wounds," Halsted,[5] in 1890, refers to 13 instances in which operations were performed for carcinoma of the breast. The hospital numbers of these cases are recorded and in one instance, No. 381, the clinical history and the technic of the operation are as follows:

Wealthy Mason, age 47, was admitted to the hospital, March 20, 1890. About one year ago the patient noticed a lump no larger than a pea just external to the left nipple. The lump has gradually increased in size and is now about as large as a hen's egg. The axillary nodes are large enough to be felt.

Operation.—March 21, 1890: The knife was introduced at a point from 3 to 5 cm. below the middle of the clavicle and drawn outwards on to and down the arm to a point a little below the insertion of the pectoralis major muscle. The knife was then reintroduced at the starting point and the tumor circumscribed by a skin incision which gave the diseased tissues at every point a wide berth—a berth of at least 5 cm. Each bleeding point as it presented itself was caught at once by an artery clamp. The tumor, the entire breast and all of the healthy tissues which had been circumscribed by the skin incision were removed in one piece from within outwards, by cutting and tearing, from the ribs and from the fascia which covers the greater pectoral muscle. The triangular skin flap was dissected back to its base. The loose fascia which stretches from the lower border of the free edge of the pectoralis major muscle to the chest wall was torn through with the fingers, the major muscle was raised up from the chest wall and from the pectoralis minor muscle and cut away close to its trunk attachments and at about 5 cm. from its insertion into the humerus. The pectoralis minor muscle was divided transversely at about its middle and drawn upwards so as to completely expose the extreme apex of the axilla under the clavicle. The loose cellular tissue about the first portion of the axillary vein was dissected away with the fingers so as to clearly expose the axillary vein. Starting from this point the tissues were dissected clean from the axillary vessels and nerves, down almost to the lower limit of the skin incision on the arm. Going back again to the apex of the axilla, the axillary contents and with them all the cellular tissue and fat which covers the front and side of the exposed chest wall were dissected off, clean from the ribs. The somewhat wedge-shaped contents of the axilla were thus removed in one piece from the apex to the base or floor of the axilla. The floor of the axilla had already been reflected in the triangular skin flap. The last cutting act of the operation, therefore, was to dissect the base of the wedge-shaped contents of the axilla from the reflected triangular flap of skin.

In 1894, Halsted[6] published a paper containing a description of the technic of an operation which he states had been employed in 50 cases from January, 1889, to January, 1894. This technic he calls his complete operation, although it did not include removal of the pectoralis minor muscle.

This paper also contains brief abstracts of the clinical histories of the 50 cases, in each of which the hospital number and date of operation are given. In one instance, Case 1, Surgical Number 12, there is a description of the operator's technic in which, because of an abscess in the axilla, the breast and pectoral muscles and the axillary contents were removed at separate operations.

In 1898,[7] Halsted stated that the operation he was employing was more radical than at the time of his first publication, because he was removing the supraclavicular lymph nodes. In 1907, he[8] recommended extension of the operation in some cases to include the removal of a part of the chest wall. In 1921, in Doctor Halsted's[9] last paper dealing with the operative treatment of cancer of the breast, he adds emphasis, by the use of italics, to the following statement concerning the radical operation:

"The initial account of the operation for cancer of the breast which bears my name lies buried in the second volume of the Reports of the Johns Hopkins Hospital under the title 'The Treatment of Wounds with Especial Reference to the Value of the Blood Clot in the Management of Dead Spaces.' "

From these quotations it is clear that although all of those who were fortunate enough to be associated with Doctor Halsted while he was performing operations for the cure of carcinoma of the breast have an indelible picture of a Halstedian operation, others, because of the continuously changing technic and even conflicting statements in the published accounts, would probably obtain quite different ideas of the Halsted operation. For example, it is strange that the description of his operative technic in 1894 should have omitted the removal of the pectoralis minor muscle when the case records show he was occasionally removing this muscle as early as 1892.

It is also difficult to understand why Doctor Halsted should, in 1921, refer to the description of the breast operation in his paper of 1890 as the first account of his operation, when this operation so obviously violated the principles emphasized by him in 1894, and particularly because he, in 1894, apparently did not consider this case as having had his complete operation.

These discordant facts are not related for any other purpose than to call attention to the fact that there is no such thing as a radical operation for carcinoma of the breast as there is a Billroth II for carcinoma of the stomach, and that even Doctor Halsted was somewhat confused as to what constituted the operation bearing his own name.

During the present year, we have been able to determine the present condition of every patient admitted to the Vanderbilt University Hospital with carcinoma of the breast during the past 14 years. In most of the patients who were treated by radical operation, the same technic, both as regards amount of tissue removed and the manner of its removal, has been employed. One hundred forty-nine radical operations have been performed, with one death from wound infection. At present (1939), 72 cases, having had the

same operative technic, have been operated upon for periods longer than five years. In all these cases there is no doubt of the correctness of the diagnosis and all of the specimens removed have been studied carefully as to the type of tumor and particularly as to the extent of the disease. Ten other cases operated upon for more than five years are not included because of some doubt as to the diagnosis or the authors' not being sure of the exact operative technic employed.

The operative technic employed is briefly as follows:

(1) The first step in the operation is to make a circular mark on the chest wall to include the skin to be removed. The size of the circle varies according to the proximity of the tumor to the skin, but is only in exceptional instances small enough to permit closure of the wound without skin grafting. After the circle has been marked off, the actual incision employed has varied in configuration but was always outside the circular mark. Most frequently, this incision has been similar to that proposed by Rodman and modified by Greenough.

(2) The skin with very little subcutaneous tissue is raised from the entire axilla, deltoid region, and the chest wall from the medial aspect of the mammary gland to the opposite side of the sternum and slightly above the clavicle.

(3) The subcutaneous tissue and fascia are then incised from the anterior margin of the latissimus dorsi muscle, around the axilla, along the cephalic vein, and the inferior margin of the clavicle.

(4) The above incision is continued in depth until the insertions of the pectoral muscles are divided and the clavicular portion of the pectoralis major muscle is divided along the inferior margin of the clavicle.

(5) The axillary contents are separated from the vessels and nerves by sharp knife division in a plane across the axilla at the inferior border of the axillary vein. All branches of the vessels and nerves are divided at the level of the inferior margin of the vein. No attempt is made to dissect structures at a higher level. The incision is extended through the axilla to its posterior wall and thence to the chest wall.

(6) The lateral skin flap is then elevated to a line lateral to the anterior margin of the latissimus dorsi muscle, the costal margin and the xiphoid process.

(7) The subcutaneous tissue and fascia are then divided down to the chest wall, beginning at the posterior axilla, along the anterior margin of the latissimus, across to the xiphoid process, and finally to the sternoclavicular joint.

(8) *This completes the division of the margins of the block of tissue to be excised.*

(9) The entire mass is then cut away from the chest wall with the least amount of traction and tearing.

In patients subjected to radical operations we believe the extent of the disease as determined at operation or from subsequent study of the gross specimen is far more important in prognosis than any classification of tumors according to "grades" of malignancy. This series of patients is, therefore, divided into three groups:

Group I: No demonstrable cancer outside the mammary gland at operation or from subsequent gross and microscopic examination of the tissues removed.

Group II: No cancer observed during the course of operation but cancer later demonstrated in inferior axillary lymph nodes by microscopic study.

Group III: Cancerous nodes seen in the axilla or near the chest wall at the time of operation.

In all cases placed in Group III the operative note contained a specific statement that cancerous tissue was seen during the operation. In most of the cases included in Group II the operative note made a specific statement that no enlarged lymph nodes were seen. A few instances in which the operative note contained no statement bearing on this point were placed in Group II. Group I contains the cases in which microscopic examination of numerous axillary lymph nodes showed no tumor.

The results obtained from the employment of the operative technic previously described in 72 cases, all of whom have been operated upon for more than five years, are shown in Tables I, II, and III.

TABLE I

PATHOLOGIC CLASSIFICATION

	Number of Cases	Living and Well	Living with Recurrence	Dead, Recurrence	Dead of Other Causes	Per Cent Cured 5 Years or Longer	Per Cent Now Living and Well
Group I.....	12	11	0	1	0	91.6	91.6
Group II.....	29	10	2	17	0	34.5	34.5
Group III.....	31	4	1	25	1	16.1	12.9
Total.....	72	25	3	43	1	36.1	34.7

From Table I it appears that the operative procedure employed in this series of cases can be expected to cure 90 per cent of cases of cancer of the breast if there is no demonstrable tumor outside the mammary gland, but it is also true that there is no evidence contrary to the conclusion that equally good results in these particular cases could not have been obtained by much more conservative means. In fact one of the patients not included in this report is well 11 years after a simple mastectomy, because a severe infection prevented radical removal.

TABLE II

	Interstitial Radiation (Keynes)		Radical Mastectomy (Vanderbilt University Hospital)		
Pathologic Classification	Number of Cases	5-Year Survival Rate	Number of Cases	Living and Well 5 Years	5-Year Survival Rate
Carcinoma without axillary metastases.....	75	71.4%	12	11	91.6%
Carcinoma with axillary metastases.....	66	29.3%	60	16	26.7%

In spite of the fact that only one-third of all the patients with metastases to the lymph nodes nearest the mammary gland were apparently cured by operative treatment, the results obtained in this group are after all the principal support of the value of radical operative treatment. These patients could not have been cured of the disease by a simple mastectomy and all of my experience has been contrary to the view that as good survival periods could have been obtained by the employment only of conservative operations.

TABLE III

Number of Years Followed	Groups I	II	III	Total Number of Patients	Number Now Living and Well	Per Cent Now Living and Well
13	0	5	4	9	3	33.3
12	0	2	1	12	4	33.3
11	1	2	2	17	6	29.4
10	2	1	3	23	9	39.1
9	2	3	4	32	12	37.5
8	1	2	3	38	13	34.2
7	0	6	6	50	16	32.0
6	4	3	3	60	23	38.3
5	2	5	5	72	25	34.7

The distressingly poor results obtained after operations in which cancerous tissue appears in the operative wound, particularly because this group is largest in number, although constituting most of the evidence against the efficacy of the operative treatment, is the strongest evidence for the assertion that, if operative treatment is to be undertaken, it should conform, in greatest degree possible, with the fundamental principles on which this treatment is based, and emphasizes the apparent necessity of any curative operation having to extend well outside the limits of visible tumor. If, however, this large group, found almost hopeless at operation, is added to the one-third of all breast cancers found hopeless before operation, it brings into bold relief the smallness of the accomplishment of the radical operative treatment of cancer of the breast, and the importance of determining the relative usefulness not only of each of the widely varying operative technics, but also of other methods more recently discovered.

REFERENCES

[1] Mitchiner, Philip H., Bailey, G. N., and Price, A. K.: St. Thomas's Hosp. Rep., **2**, 2nd Series, 192, 1937.

[2] Keynes, Geoffrey: ANNALS OF SURGERY, **106**, 619, 1937.

[3] Ogilvie, W. H.: Guy's Hosp. Gaz., **53**, No. 1326, 172, May 20, 1939.

[4] Moore, Charles H.: Medico-Chirurg. Trans., **40**, 245, 1867.

[5] Halsted, W. S.: Johns Hopkins Hosp. Rep., **2**, 255, 1890–1891; Maryland Med. Jour., **24**, 529, 1891.

[6] Halsted, W. S.: Johns Hopkins Hosp. Rep., **4**, 297, 1894–1895; ANNALS OF SURGERY, **20**, 497, 1894.

[7] Halsted, W. S.: ANNALS OF SURGERY, **28**, 557, 1898.

[8] Halsted, W. S.: ANNALS OF SURGERY, **46**, 1, 1907.

[9] Halsted, W. S.: Johns Hopkins Hosp. Bull., Baltimore, **32**, 309, 1921.

DISCUSSION.—DR. ROY D. MCCLURE (Detroit, Mich.): There are a few of us here to-day (James Mitchell, George Heuer, Willis Gatch and myself [Doctor Brooks himself was there for a time]) who spent many years with Doctor Halsted, serving as Assistant Residents and Residents. One thing we can say is that many who to-day claim to be performing the Halsted breast amputation are not carrying out the Halsted procedure as he himself performed it. He took perhaps three hours or more, and few to-day would think of devoting three hours to the operation. Halsted may have been a slow operator, but he was moving every minute of the time, and I can assure you that the assistants had to be alertly on their toes.

My main criticism to-day is that some who claim to perform the Halsted amputation take so little skin that they are able to close the defect without a skin graft. When I was Halsted's Resident, we removed a liberal margin of the skin and never worried about how large a graft was to be used. All the Residents of that time acquired great skill in removing large sheets of intact skin from the thigh. To-day, with the instruments available, almost anyone can easily take such skin grafts, so that now perhaps surgeons will not be so loath to undertake large areas of skin removal. Doctor Halsted spent much time on the axilla, and it was time well spent. The vessels and nerves were clean when he finished with them. There were no nodes and no node-bearing tissue left. Even before this Society I have heard described as the Halsted operation a procedure which was not the Halsted operation as I learned it directly from him. Those who are familiar with his work know that his patients did not suffer any shock, and I believe his results have never been surpassed even though Sampson Handley's work in the lymphatics and the manner of spread of cancer of the breast may be questioned. Halsted did his radical operation long before Sampson Handley's lymphatic work was brought to our attention; I believe it was conceived from his study of actual recurrence areas and actual metastatic areas. It was based, then, on an actual study of such patients and not on a theoretic study of possible line of spread through the lymphatics.

Last year, Dr. Arthur McGraw and I reported briefly our results before the Society of Neoplastic Diseases. Our results showed that half our own cases had received adequate irradiation by deep roentgenotherapy. This treatment had no effect on the end-results. I hope that Doctor Brooks' communication will not turn you too much from the radical type of operation.

DR. CHARLES LUND (Boston, Mass.): First, I must tell you what an honor and pleasure it is to be asked to come here to this meeting and to be allowed to join in the discussion. We have a long series of studies of cancer of the breast, started by J. Collins Warren and continued by R. B. Greenough and others in Boston. We would agree, 100 per cent, with the conclusions of the two papers presented, and we believe fully in radical operation for operable cases. I am not going to enumerate all our ideas. First, there should be elimination from surgical treatment of inoperable cases, cases where there is fixation to the chest wall, or with metastases beyond the axilla. All cases get a roentgenologic examination of the chest, spine, pelvis and skull to find if there are evident metastases in the lungs or bones. If there is any great edema of the breast or skin metastases, the cases are also inoperable. We get about the same results that Doctor Brooks reports. We have some statistics which I think should be interesting to anybody considering the subject of simple mastectomy versus radical mastectomy as a comparison of preoperative estimations of malignancy of the nodes, with what was found.

If you take 100 cases in which a good surgeon says, after examination, that the axillary nodes are positive and then look at the pathologic findings

following a radical removal, you will find, nine times out of ten, that he was right. Occasionally, there are enlarged nodes that are not positive. But if you take his estimation, when he says the nodes are not palpable and are not involved, we find he is wrong 40 per cent of the time. If such nodes are not removed, we do not believe any postoperative roentgenotherapy will control them for any length of time. We base this on hundreds of cases studied at the Massachusetts General and the Collis B. Huntington Memorial Hospitals.

As to irradiation of the ovaries in cancer of the breast, we had a similar case some years ago in which Dr. G. W. Taylor reported the findings. With us, this procedure is apparently dying out. We are not getting the results we hoped for and are giving it up. We are not using postoperative irradiation as Doctor Trout does. We are using more than we were a few years ago. We formerly believed it was unimportant in all cases and we gave it only if there were recurrences. We have changed that to some extent. The pathologist now gives us a report of carcinoma of the breast of such and such a grade, with so many nodes involved, and if there is no involvement of the axillary nodes or only one or two are involved, we give no postoperative treatment unless recurrence takes place. However, if many, or most, of the nodes are involved or if the tumor is highly malignant, we do give postoperative treatment at once without waiting for metastases to become evident.

Dr. Rollin A. Daniel, Jr. (Nashville, Tenn.): I would like to present, very briefly, some additional data concerning the group of patients which Doctor Brooks presented. The 72 cases reviewed are included in a total of 120 patients seen at the Vanderbilt University Hospital, during that period of time. Since only 12 of these patients fall into Group I, I think it is fair to say that only 10 per cent of the patients with carcinoma of the breast who presented themselves for treatment could have been cured by simple mastectomy, or by any operative procedure less radical than the operation described by Doctor Brooks.

Table I reviews briefly the roentgenotherapy employed in the 72 cases reviewed in the text of Doctor Brooks' paper. Roentgenotherapy was not administered preoperatively in any case in this group; and this table does not consider patients who were treated after recurrences were found. In all instances, from one to four large doses of irradiation were administered, which were measured on a basis of skin-erythema dosage, and in no case was carefully measured, protracted irradiation, as it is used now, employed.

TABLE I

PERCENTAGE OF CASES IRRADIATED AND RESULTS

	Total Number of Cases	Number Living and Well	Per Cent Living and Well	Groups	Number of Cases	Number Living and Well	Per Cent Living and Well
Given roentgenotherapy	19	6	31.6	I	3	2	66.6
				II	7	3	42.8
				III	9	1	11.1
Not given roentgenotherapy	53	19	35.8	I	10	10	100.0
				II	21	6	28.5
				III	22	3	13.6

Table II is based on data obtained from patients' histories. The similarity in the last two groups is striking. It is also interesting that the number of

patients considered hopelessly far advanced, when first seen, is larger than the group of patients who have remained well for periods of time exceeding five years.

TABLE II

AVERAGE DURATION OF LIFE AFTER TUMOR WAS FIRST NOTICED BY PATIENT

26 patients cured 5 years or more after radical mastectomy: 9 years, 1 month (all living now but one).
41 patients having recurrence within 5 years after radical mastectomy: 3 years, 5 months.
38 patients considered inoperable when first seen: 3 years, 3½ months.

DR. WALLER O. BULLOCK (Lexington, Ky.): I would like to discuss one point in Doctor Trout's paper and say that, in irradiation of the pelvic structures, particularly the ovaries, to prevent involvement of the opposite breast, it would seem that simple mastectomy of the opposite breast in a young woman is much less mutilating to her personality than a procedure which suppresses menstruation.

DR. JAMES F. MITCHELL (Washington, D. C.): I would like to add a word to what Doctor McClure has said. I worked with Doctor Halsted for ten years, from 1893 to 1903, and during that time he was developing his breast operation, adding a little more each year, and his operation, as Doctor McClure said, was long and tedious. Bloodgood carried the operation further, and after Halsted had finished, Bloodgood would go on. I think Follis made the best comment: He said two men ought to perform every breast operation; and the best thing was that they should be bitter enemies. The first man should perform the operation and leave the second man to close the defect. There would be plenty of exposure for him to make. We are all coming back to Halsted's teaching in the matter of breast operations and the matter of silk. I was brought up on silk and have always used it, and to see men come back to it is a great tribute to Halsted's wisdom. We, who had the pleasure of working with him, knew his meticulous care in operating and in all the things for which the whole country owes him a debt of gratitude.

I feel that Doctor Trout's ideas as to the treatment of carcinoma of the breast represent the most thorough and most rational scheme of to-day.

DR. L. WALLACE FRANK (Louisville, Ky.): There is one thing which was mentioned by Doctor Mitchell that I wish to call to your attention, and that is the skin incision. Since 1919, I have performed radical mastectomy for cancer of the breast in about 190 cases and in none have I found it necessary to do a skin graft. I might also add that in this number I can recall only three patients who developed local skin recurrence. The frequency of local skin recurrence and of axillary recurrence is in a measure an index of the thoroughness of the operative technic. We see very few recurrences in the nodes in the axilla. We do have recurrences in the nodes above the clavicle. What we see most frequently are pleural, lung, liver, and bone metastases.

I do not think that we *cure* cancer of the breast; we only arrest the disease. I have seen too many patients die 8, 10, 12 and even 15 years after operation due to a recurrence, or, rather, I should say recrudescence of their disease. Many of these patients died as a result of bone metastases. It goes without saying that when there is no recurrence in the operative area and the patient dies some years later of distant metastases, that these metastases had occurred previous to operation. Why these cancerous deposits should lie inactive for so long without giving any signs or symptoms, no one can say. When

we find out what the stimulus is that starts these dormant cancer cells to again become active we will have gone a long way toward finding the cause of cancer.

DR. HUGH H. TROUT (Roanoke, Va.): In my original paper many other points will be covered which are not contained in the paper read here.

There is one rather serious and usually unrecognized danger of irradiation. If one believes that irradiation has any virtue, one is apt to become careless as regards the extent of thoroughness of the operative procedure. I say this in spite of the fact that many of us here were trained either directly or indirectly by Doctor Halsted and are firm believers in his teachings.

Concerning the inoperable cases: We have had 11 such cases that we considered absolutely inoperable, and treated them with irradiation. After a few months of irradiation, six of these cases became what we considered a fair operable risk. Three of these six cases have remained free from carcinoma over five years following operations.

Nodes in the axilla present an interesting study. For example, one node in the axilla apparently offers a better prognosis than many small, shot-like nodes. Doctor Ewing is under the impression that one large node demonstrates that malignancy has been effectively plugged, and that shot-like nodes suggest that the malignancy has percolated through. We have had five cases in which extensive search of the axilla showed no signs of nodes at the time of operation or in the specimen examined after operation, yet all five of these cases died of metastases. This experience suggests that, in a certain number of cases, extension occurred through the blood stream and not through the lymphatics.

We have irradiated the ovaries in very few young women, certainly not enough to have any definite views on this subject.

In reply to Doctor Bullock's question, I will state that amputation of the remaining breast would only be part of the picture, for by irradiation of the ovaries is not only hoped that the remaining breast may be spared but, also, that the development of metastases may be prevented elsewhere in the body.

DR. BARNEY BROOKS (Nashville, Tenn., in closing): I would like to add emphasis to my feeling that the advisability of treatment of carcinoma of the breast solely by operation is now being justly questioned. There are a great many thoughtful surgeons who are definitely of the opinion that this operation will not be very much longer employed. This method of treatment should not be condemned on the basis of poor results obtained by the employment of any operative technic which does not conform to the principle on which the radical operation is founded. There is much need at the present time for a very careful study of the whole question of treatment for carcinoma of the mammary gland.

THE RÔLE OF IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE BREAST*

HUGH H. TROUT, M.D.
ROANOKE, VA.

I CERTAINLY hope no one will receive the impression—no matter what I might say concerning irradiation—that I consider that there is, at present, any substitute for the radical operation in the treatment of carcinoma of the breast. Of course, much harm can be done by an improperly executed operation in this disease. Also, even more harm can be done when properly executed operations are performed in badly selected cases. In neither of these instances should surgery be condemned. The same rule of fairness should, I think, be applied to the application of irradiation in association with surgery in the treatment of carcinoma of the breast. The great difference is, however, that surgery, after many years of study, is now more or less standardized in its application to the treatment of this disease. Such is, certainly, not as yet the situation relative to irradiation. Assuredly, this lack of standardization adds to the confusion of determining as to what is the correct procedure relative to the application of irradiation to surgery in the treatment of carcinoma of the breast. I am even more firmly convinced that improper irradiation can, and frequently does, do more harm than even improperly applied or badly executed surgery, for the boundaries of the chest wall and axilla limit the field in which surgical mistakes can be made, while no one knows the full extent of damage done by improperly applied irradiation.

There are many advocates of the irradiation treatment in this disease, who believe the time is near when roentgenotherapy and radium will take the place of surgery in the treatment of carcinoma of the breast, somewhat as they have done in the treatment of carcinoma of the cervix. I personally do not share this belief, for I feel the breast, muscles, nodes, *etc.*, can be more thoroughly, more easily, and more safely removed without contamination of the operative field by the spreading of stray cancer cells, and, certainly, with a very much lower mortality than the uterus, nodes, *etc.*, can be completely removed from the pelvis.

The views I am about to express are my own personal opinions which are based on: (1) An interested and extended study of the literature; (2) my contacts with surgical and radiologic friends (both those believing in the efficacy of irradiation as well as those holding "no brief for any of it"); and (3) an intimate and close study of over 600 cases of carcinoma of the breast observed for over a quarter of a century. Lastly, and most certainly, my opinions are not based on any facts, for facts are unknown in association with irradiation. However, I cannot help but believe that physical agents, which

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

have so revolutionized and improved the treatment of cancer elsewhere in the human body, can and should be of aid in extending the effectiveness of the surgical removal of carcinoma of the breast, provided such agents can be employed without doing damage to uninvolved tissues.

The effects of radium and roentgenotherapy will have to be considered both from their remote as well as their local application.

It has been most interesting to me to watch the changing attitude of the medical profession relative to whether preoperative irradiation, postoperative irradiation, radium or combination of all three should be employed. The only actual *fact* that I know definitely concerning irradiation is that the type, the time, the frequency, and the response require a careful study of each individual case; also, that such a study should be made with the close and the frequent cooperation of a group consisting of a surgeon, a radiologist, a pathologist, and, whenever possible, the family physician. Also, in our part of the country, this group should include the hospital managers, for it is unreasonable to expect cooperation from the patient and from the family unless they know, fairly definitely, what the combined cost of their experience with this group is to be. I am confident we have failed in the past to obtain the proper cooperation from the patient and from the family because we had not given them complete information concerning their financial obligations. This is particularly true with families who are too foolish, and too proud, to admit their financial situation is not as good as the community believes it to be.

Before considering any of the combinations of irradiation employed with surgery, I am firm in my opinion that any form or frequency of irradiation that produces necrosis or an extensive destruction of the skin is harmful. Also, if the irradiation is so intense as to do damage to the skin, it is reasonable to presume malignant invasion will take place more frequently and more rapidly than if the protective influences of surrounding tissues had not been injured by roentgenotherapy. In other words, if the irradiation is too intense, recurrences are apt to occur, and when they do appear the skin will be in no condition to receive further irradiation.

Furthermore, I am certain, a trial dose of irradiation, whenever possible, should be employed to obtain some idea of the skin response of that individual patient to irradiation. I will not discuss further the dosage of irradiation, for this is not the function of a surgeon.

Of course, the dosage, the character and the type of machine, *etc.*, have all changed from year to year, which, necessarily, only adds to the confusion in trying to make a proper estimate of relative values with the various methods. In addition, I am not competent to discuss that which is the distinct function of the radiologist. However, we have made some general observations concerning the patient's reaction to irradiation that are interesting.

For example, we feel that young women will be found, as a general rule, to have that type of malignancy which is more radiosensitive than is found in the older group. In other words, histologic Groups 3 and 4 are more

frequently found in young women than Groups 1 and 2. Also, the clinical index is much higher in the younger group. Theoretically, the addition of irradiation to surgery should improve the prognosis in this group of cases even more than it does in the older women. We feel this has been true in our series, but, of course, have no way of knowing definitely concerning the accuracy of this observation. Also, better results are obtained in the younger group by giving irradiation at shorter intervals than seems advisable or necessary with older women. Perhaps this is due to the fact that in an actively growing malignancy, cell division takes place more rapidly, and as is well known, irradiation is more effective on the immature cells. This is but one of the many reasons illustrating the necessity of group observation in the proper treatment of carcinoma of the breast. I feel quite certain a study of the life cycle of the cancer cell is of much aid in determining the type, the dosage and the frequency of irradiation necessary to obtain the best results in any malignancy.

In our series, there have been found more inoperable cases of carcinoma of the breast in young women than have been found in women past the menopause. This is probably due to the fact that in such cases the growth of the malignancy is more rapid than it is in the older group.

It is our general plan to: First, employ preoperative irradiation; second, at the time of operation to place many small tubes of radium around the entire operative field and under the skin; and third, to follow this with postoperative irradiation. In addition to these three forms of application of irradiation, we have, in quite a few cases, employed irradiation of the pelvis.

Perhaps it would be of profit for us to discuss some of the indications and some of the contraindications for the employment of preoperative irradiation in different types of cases. It is, however, our general aim to employ all three types of irradiation in every case possible.

We do not feel that preoperative irradiation is as effectively administered in our organization as we would like it to be. We do not seem to be able to control our patients as well as some other organizations with which I am somewhat familiar. With us, our patients will not permit us to take the two to three weeks' preoperative preparation that is apparently required to obtain the best results. Also, some of them fail to return at the appointed time—when the mass begins to become smaller—but delay continuation of their treatment until the malignancy has had time to extend beyond the reach of surgery and irradiation. For this reason, we have been employing, in some cases, doses of roentgenotherapy that require only 48 hours of preoperative irradiation, but, of course, we have no method of estimating the effectiveness of this method. However, we hope, and we believe, it is reasonable to presume that cancer cells, after exposure to such irradiation, are made less active and, therefore, any stray cancer tissue remaining in the field of operation might not be so apt to attach itself to surrounding tissue.

Preoperative irradiation, we feel, is especially indicated in the following cases: (1) Those patients having palpable nodes in the axilla. It is interest-

ing to recall that where one large single malignant node is found in the axilla, the prognosis as regards metastases is far better than in those cases having small, shot-like nodes. Many pathologists feel one large malignant node is a demonstration of the effectiveness of that particular node to block further spread of the malignancy, whereas the presence of numerous small, shot-like malignant nodes is an expression of the inability of the lymphatics to successfully limit the extension of the malignancy.

Of course, we have all seen cases of carcinoma of the breast in which a careful microscopic study of the nodes removed from the axilla showed no signs of malignancy and yet these patients soon developed metastases in distant parts. In such cases the cancer cells are probably carried to the site of the metastases by the blood stream and not by the lymphatic system.

(2) Those cases in which the malignancy is fixed either to the skin or to the underlying muscle.

(3) A limited number of cases, who, due to senility, cardiac or some such general condition, are not able to take a prolonged anesthesia with sufficient safety to justify the risk, can be brought, in a few instances, to the stage in which the breast can be removed under a local anesthetic, and with both physical and mental comfort to the patient.

(4) Those cases of very rapidly growing malignancy, especially if associated with infection.

(5) Those cases associated with pregnancy.

(6) A few apparently inoperable cases can be so improved by preoperative irradiation that a radical operation can be performed with a fair prospect of prolonging life.

(7) In those cases where there has been an implant of the carcinoma in the tract of an aspiration biopsy needle. We have had two such cases, and in both of them the biopsy diagnosis was that no malignancy was found, yet carcinoma developed right under the skin at the site of the needle puncture. We have never considered the punch or aspiration biopsy to be either a safe or an accurate method of making a diagnosis of carcinoma of the breast.

Radium at the Time of Operation.—We use 15 to 20 small needles (3 to 5 mg. each) of radium implanted under the skin at the time of operation in different localities, giving especial attention to the axilla and the territory drained by the internal mammary lymphatics, for these are the two most frequent localities of local recurrences. Strings are attached to these needles, and they are gradually withdrawn at the lower end of the incision. The pull on the strings is started about 12 hours after completion of the operation, and they are then withdrawn about one inch each hour. We formerly employed larger doses of radium in capsules, but obtained some skin necrosis as well as two cases of necrosis of the costal cartilage which required removal of a section of the cartilage. We feel the small needles are a distinct improvement. Radium is not employed in those cases requiring skin grafts. We are impressed with the fact that, in recent years, we have been employing skin

grafts more frequently as our incisions are now being made at a far wider distance from the growth than they were a few years previously.

The field of operation is also flushed out with several quarts of saline solution, as hot as can be tolerated by the hand. Of course, it is well known that even a relative low degree of heat will kill cancer cells, and it is possible the flushing process might also wash out some detached malignant cells.

Geoffrey Keynes reported a series of cases in which he performed a simple mastectomy with absolutely no dissection of the axilla, but implanted radium needles to take care of the involved lymphatics. He stated that there were no swollen arms following the implantation of radium in the axilla. We have never seen any postoperative swollen arms except in those cases that have had some infection in the axilla. Halsted and his coworkers demonstrated many years ago that an infection prevents the regeneration of lymph canals.

Keynes also reported a few cases of brachial nerve neuritis. In addition to these complications, his results did not, in my opinion, justify the continuation of this practice.

Reports, such as Keynes, help create a distinct, and frequently unrecognized, danger to the employment of irradiation in association with surgery—the surgeon who believes too strongly in the efficacy of irradiation might allow himself to become somewhat careless in the thoroughness of his dissection.

In my opinion, whenever possible, the radical operation should always be performed. Preference should not be given to less radical methods purely because they might perhaps be attended by a lower operative mortality. When dealing with cancer, the value of any method should not be estimated entirely by the operative mortality rate, but by the effectiveness with which recurrences and metastases are prevented.

Keynes, later, reported a series of cases treated by interstitial implantation of radium needles. In a number of these cases he removed the breast after about six months, following this type of irradiation. Examination of these specimens of amputated breasts showed no signs of carcinoma in over 50 per cent of the cases. The microscopic picture suggested an almost complete fibrous replacement of the malignancy. In a few cases carcinomatous cells encapsulated by fibrous tissue were found. Ewing reports a somewhat similar microscopic picture to exist in the breast following preoperative external irradiation.

McKittrick tried Keynes' method in a series of cases, and concluded that interstitial irradiation was not desirable for the following reasons: Pain in the breast; fixation of the pectoral ridge; and late deformity. He also considered that the final results did not justify the abandonment of the radical operation.

We give postoperative irradiation to all cases and try to start the same about ten days after the operation. This method also applies to those cases having skin grafts. Apparently irradiation kills the skin graft if applied in

less than ten days of the time of the placing of the graft over the field of operation.

In the period extending from 1909 to 1920, there were 152 cases in which only the radical operation was performed. In this group, there were ten local recurrences, and the percentage of three-year (or over) "cures" was 22 per cent. In the period extending from 1920 to 1924, there were 80 cases in which radium under the skin was added to the radical operation. In this group there were four local recurrences, and the percentage of three-year (or over) "cures" was 30 per cent.

In the period extending from 1924 to 1939, there were 211 cases in which radium and postoperative roentgenotherapy were added to the radical operation. In this group there were eight local recurrences, and the percentage of three-year (or over) "cures" was 55 per cent.

In the period extending from 1924 to 1939, there were 126 cases in which pre- and postoperative irradiation, as well as radium, was added to the radical operation. In this group there were no local recurrences, and the percentage of three-year (or over) "cures" was 55 per cent.

From a review of these figures, one might conclude that the improvement in the percentage of three-year (or over) "cures" was due to the addition of irradiation to the radical operation, but I feel quite confident that this improvement is due to education more than any other one factor. Of course, it is impossible to accurately state how much, if any, irradiation has had to do with this improvement. It is, however, reasonable to presume if its use had decreased the percentage of local recurrences it might have prevented some of the metastases which may have occurred. However, the reason I state that I think education has had more to do with our good results than any other one factor is that we are certainly seeing our cases of carcinoma of the breast much earlier than we formerly did.

It is the general practice throughout the country to treat local recurrences with irradiation after such have occurred, but I am sure it is better, if possible, to prevent such local recurrences by the addition of irradiation to radical surgery, in spite of the fact that absence of local recurrences does not apparently improve the percentage of "cures."

There have been 11 cases in which it was impossible to remove all of the malignancy from the chest wall. Radium needles were inserted in the remaining malignancy and intensive postoperative irradiation administered. All of these cases soon died from metastases, but in nine of the 11, the malignancy was removed from the chest wall by the addition of irradiation before the death of the patient.

We have had five cases from which we have removed only the breast, believing, at the time of operation, that no malignancy was present. In all five cases we considered the condition to be a benign tumor associated with a generalized cystic mastitis, and, therefore, removed the entire breast. In none of these cases did the frozen sections show carcinoma at the time of operation. Malignancy was discovered several weeks following operation,

following an extended study of the permanent sections, and then irradiation was administered. Fortunately, there has been no return of the malignancy in any of these five cases. Probably the malignancy was so early in all five of these cases that all that was necessary was the simple amputation. However, the delayed postoperative irradiation did no harm to the patient either mentally or physically, and might have done some good.

We were not able to obtain a single autopsy in any of the cases that died of metastases, and, therefore, do not have any definite knowledge concerning the presence of residual malignancy in the axilla. Nor can we be absolutely positive that there were no local recurrences. All we can report is that we examined all these cases some months, and often years, after operation, and found no local recurrences in this group. Then, also, we have reports in every case from either the family physician, or some member of the family, to the effect that no local recurrences occurred either in those cases still living or those cases that died from metastases or from other causes. We try to examine every patient once every month, for a six-month period, and then every three months for five years.

I feel we can conclude from this experience that proper irradiation of the chest wall aids radical surgery only in the prevention of local recurrences and not in the "cures." In other words, it is the metastases that kill and not the local recurrence.

We have had some very interesting experiences in the employment of roentgenotherapy for the relief of pain associated with metastases. In the majority of cases the pain has been relieved, but, as far as we can ascertain, there has been no prolongation of life—only the alleviation of pain and some mental comfort, both of which fully justify the employment of roentgenotherapy in such cases.

In 1931, Dr. C. H. Peterson treated a case that had extensive metastatic involvement of the bony pelvis, associated with an inoperable and ulcerating carcinoma of the breast. After several weeks of irradiation of the pelvis, the pain not only subsided in the pelvis, but the malignant ulceration of the breast showed such marked improvement that the skin healed over the ulcer and the breast lesion ceased its foul-smelling discharge. Of course, this patient went on to her death, apparently as if there had been no improvement in the breast condition. This experience made us have a natural curiosity as to what possible association there could be between the improvement of the breast condition and the irradiation of the pelvis. About the same time we were speculating concerning such a relationship the radiologists began to advocate the irradiation of the pelvis, and many advanced the theory that the beneficial results were due to the action of the roentgen rays upon the ovarian hormones.

There have been many theories advanced to explain what does actually happen when the ovaries and their hormones are exposed to the influence of the roentgen rays. However, I feel quite confident no one has any definite knowledge regarding this relationship. Clinical observations do not always

seem to coincide with the various theories advanced. For example, if irradiation decreases the production of carcinogenic hormones by the production of an artificial menopause, why is it that carcinoma of the breast is more frequent during those years following a natural menopause? This apparent conflict naturally raises the question as to whether the ovaries should be irradiated in those cases who are below the age of the normal menopause. However, some of the best clinical results reported have been in young women. For example, those cases of lung metastases which have disappeared after irradiation of the ovaries have been in young women in the majority of cases. In our limited experience the most marked benefit we have seen in the breast condition has been in the young women with rapidly growing carcinoma of the breast who have had preoperative irradiation of the local condition as well as the ovaries.

Sufficient experimental work has been undertaken to serve as a warning against the continued indiscriminate employment of estrogenic hormones for the relief of pain and swelling in the breast associated with the menses. In mice, carcinoma can, apparently, be produced by the repeated injections of such hormones. Allaben and Owen report a case illustrating the unwise use of estrogenic substance during the menopause. Certainly, there is neither the clinical experience nor the theoretic basis to justify the irradiation of either the breast or the ovaries in a patient suffering with such symptoms, in expectation of relieving the pain or preventing the future development of malignancy.

It might be that some of the remarkable results obtained in the treatment of carcinoma of the cervix by radium and roentgenotherapy are due to the effects of irradiation on the ovaries as well as due to the local application of radium.

There have been several studies of the incidence of carcinoma of the breast occurring in patients who have had their ovaries removed by operation, in comparison with a normal group of the same age. These series have been too small to be of much practical value. In over one-half of our cases of carcinoma of the breast occurring in women over 50 years of age, menstruation was still present.

Some radiologists advocate the irradiation of the ovaries in all cases of delayed menopause as a prophylaxis against the future development of malignancy, not only of the uterus, but also of the breast. Certainly, the production of an artificial menopause in young women protects the remaining breast from future lactations, and thereby decreases the chances of malignant involvement of that gland.

One naturally hesitates to inflict all the symptoms of an artificial menopause on a young woman. However, cancer is always a very serious condition, and nothing should be left undone, provided what is being done is not harmful.

In this group of young women below the menopause, we feel that irradiation of the ovaries is especially indicated: (1) If the tumor is growing rapidly. (2) If there is an associated infection. (3) If pregnancy is present. In such

cases an abortion should also be performed in addition to the irradiation, provided the pregnancy is under five or six months' duration. If malignancy of the breast develops during the last three or four months of pregnancy nothing seems to be of any benefit. (4) If the tumor is fixed to the skin or underlying structures. In other words, irradiation of the ovaries should be employed in those cases in which there exists any indication that the malignancy has extended or is going to extend beyond the chest wall. (5) As a routine practice in cases of recurrences. (6) In cases of inoperable carcinoma of the breast.

These young cases do not differ from any other instances in a surgical experience, namely, that each one has to be studied and treated as an individual case, and no general rule should be followed.

If the patient with carcinoma of the breast has passed the menopause, however, irradiation of the ovaries produces no bad symptoms, and should be administered in all cases, especially as there have been a few such cases reported where such treatment has been of apparent benefit.

I believe that all we can say at the present about the irradiation of the ovaries in association with the treatment of carcinoma of the breast, is that we do not have sufficient experience to properly evaluate the procedure as regards its true clinical value; nor am I familiar with any theory concerning its method of operation that has been advanced that fits all of the clinical results which have been reported by numerous observers. In other words, we do not now have either the clinical experience or a satisfactory theory which would justify the formulation of any definite rules governing the application of this powerful, and probably dangerous, agent. All of which means that, right at present, irradiation of the ovaries, especially in young women, should be employed only after a careful study of each individual patient, and such a study should be made by a group of doctors competent to evaluate this method, which has not as yet been standardized.

In conclusion, I feel quite confident that properly applied irradiation is of distinct aid to radical and carefully executed surgery in the prevention of recurrences, and, perhaps, of metastases in the treatment of carcinoma of the breast. However, irradiation possesses no replacement value for surgery, especially if the surgery is performed with meticulous care.

THE SCALENUS ANTICUS SYNDROME WITH AND WITHOUT CERVICAL RIB*

JOSEPH M. DONALD, M.D.,
AND
BENJAMIN F. MORTON, M.D.
BIRMINGHAM, ALA.

THE increasing frequency of recognition of symptoms due to compression of the brachial plexus and subclavian artery by the scalenus anticus muscle indicates that this condition is one of the most common causes of pain and unexplained vascular changes in the upper extremities. Attention was first drawn to the scalenus anticus muscle as a possible factor in the production of symptoms arising from cervical ribs by Murphy,[1] in 1906. The actual rôle played by this muscle, however, was not clearly understood until Adson and Coffey[2] demonstrated that section of the muscle was all that was necessary, except in rare instances, to relieve symptoms attributed to cervical rib. That the symptoms of cervical rib may exist in absence of roentgenologic evidence of the latter has been a matter of common clinical experience recorded by many observers. Bramwell,[3] in 1903, attributed the symptoms in such cases to pressure of the brachial plexus against the normal first rib. In 1919, Stopford and Telford[4] reported satisfactory results in these cases by partial removal of the first rib and incomplete section of the scalenus anticus muscle. Honeij,[5] in 1920, mentioned 19 cases with typical cervical rib symptoms in which a supernumerary rib could not be demonstrated by radiologic examination. Carroll,[6] in 1932, reported two cases in which the symptoms were attributed to abnormal first ribs. Adson,[7] in 1933, mentioned the occurrence of the cervical rib syndrome in several cases showing enlarged cervical processes which were relieved by section of the scalenus anticus muscle. In 1935, Ochsner, Gage and DeBakey[8] published a comprehensive study of the subject to which they gave the name "Scalenus Anticus Syndrome," advancing the latter as a definite clinical entity, the symptoms of which are identical with those of cervical rib. They credit Naffziger with being the first to section the scalenus anticus muscle for the relief of symptoms in absence of a cervical rib. Since 1935 several excellent contributions have appeared in the literature which confirm the scalenus anticus syndrome as a clinical entity.

The purpose of this paper is to present an analysis of 21 consecutive cases of the cervical rib and scalenus anticus syndrome studied during the past two years (Table I). Of the 16 patients that have already received operative treatment, 13 were without cervical ribs, 2 cases showed supernumerary ribs

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

Seven of the cases in this series were from the Surgical Division, Section A, of the Hillman Hospital, Birmingham, Ala.

TABLE

ANALYSIS OF 21 CASES OF THE CERVICAL

Case No.	Name	Age	Sex	Color	Side Involved	Duration of Symptoms	Unusual Use of Arm or Trauma	Pain + to ++++ Aching	Total or Partial Disability	Numbness
1	L. B.	38	M.	W.	R.	3 mos.	Use	+++	P.	+
2	J. L.	34	M.	W.	L.	6 mos.	Use	++++	T.	+
3	O. N.	44	M.	W.	L.	1½ mos.	Use	++++	T.	+
4	B. S.	52	M.	W.	R.	3 mos.	Use	+++	T.	0
5	L. H.	33	M.	W.	Bilat.	11 yrs.	Use	+	P.	+
6	C. W.	42	F.	W.	L.	5 yrs.	0	++	P.	+
7	W. S.	54	F.	W.	Bilat.	R—3 yrs. L—5 mos.	0	++	P.	+
8	R. G.	38	F.	W.	L.	6 yrs.	Use	++	P.	+
9	A. C.	48	F.	W.	L.	6 mos.	0	++	P.	0
10	W. M.	21	F.	W.	R.	5 mos.	Anesth.	+++	T.	0
11	J. D.	50	F.	W.	L.	6 mos.	Trauma	+++	P.	+
12	E. D.	32	F.	W.	L.	2 yrs.	Use	++	P.	0
13	E. B.	24	F.	C.	Bilat.	5 yrs.	0	+++	P.	0
14	R. H.	15	F.	C.	R.	1 yr.	0	+++	T.	+
15	A. F.	38	F.	C.	R.	2 yrs.	0	+++	P.	0
16	M. F.	33	F.	C.	R.	3 mos.	0	+++	T.	0
17	L. P.	48	F.	W.	Bilat.	6 yrs.	0	++	P.	+
18	C. P.	22	M.	W.	R.	2 yrs.	Anesth.	+++	T.	+
19	W. M.	43	F.	W.	R.	7 mos.	Use	++	P.	0
20	R. H.	39	F.	C.	L.	3 mos.	0	++	P.	+
21	A. J.	32	M.	C.	L.	8 yrs.	0	+++	T.	0

and one presented an abnormal first rib. In the remaining five cases, upon whom operation has been temporarily postponed, two showed roentgenologic evidence of a cervical rib. In addition, 19 cases presenting mild symptoms of this syndrome are reviewed.

Incidence.—The age incidence in the 21 cases ranged from 15 to 54 years, with an average of 37 years. The majority occurred in the fourth and fifth decades which showed nine and five cases, respectively. There were 14 female and seven male patients of which five were colored females and one a colored male. The left side alone was involved in nine cases, the right side in eight and bilateral symptoms were present in three instances. A relationship between the onset of symptoms and preceding excessive or unusual use of one of the upper extremities was shown in eight cases. A history of washing and sweeping for a number of years was obtained in five patients classified as domestic servants. The occupations of the others were varied

I

RIB AND SCALENUS ANTICUS SYNDROME

Muscular		Vas. Changes		Neurologic			
Weakness	Atrophy	Pulse	B.P. Diff.	Reflex changes Triceps = T. Biceps = B. Supinator = S.	Diminution Pain and Temp. Sensation	X-ray Findings	Results of Operation. Time of relief
+	o	o	o	o	Median	Neg.	3 days
+	+	o	o	T. & S. absent	Median	Neg.	4 days
o	o	o	Sl. elev. 3	Dim. T. & B.	o	Neg.	2 weeks
+	o	o	Elev. 8	B. absent	o	Neg.	3 days
o	o	o	Elev. 20	o	o	Neg.	No. oper.
+	o	o	Lower 35	o	Median	Neg.	Immed.
+	o	Dim. pulse. Bilat. bruit	Lower 30	o	o	Neg.	Immed.
+	o	o	o	—	—	Neg.	Immed.
+	o	o	Lower 14	—	—	Neg.	6 wks.
+	+	Bruit	Elev. 10	Rt. B. & T. abs.	o	Neg.	3 days
+	+	o	o	o	o	Neg.	No oper.
+	o	Bruit	o	o	o	Neg.	No oper.
o	o	o	Lower 14	o	o	Neg.	Immed. Periodic mild recurrence
+	o	o	o	Rt. T. & S. abs.	o	Neg.	Immed. recurr. 7 mos.
o	o	o	o	o	Ulnar median	Neg.	1 wk.
o	o	o	Elev. 4	o	Ulnar	Neg.	Immed.
+	+	o	Lower 10	Left T. dim.	Ulnar	Abn. 1st. rib	No oper.
+	+	o	o	o	Ulnar median	Rt. cerv. rib	No oper.
+	o	o	o	T. abs. S. dim.	Median	Bilat. cerv. rib	Immed.
+	o	Absent left	Left absent	o	Ulnar median	Bilat cerv. rib	Immed.
+	Gangrene	Absent left	Left absent	—	—	Bilat. cerv. rib	Immed.

and irrelevant. A history of direct trauma preceding the onset of symptoms was given in one case. In two patients the symptoms developed immediately after an anesthesia: one, following an operation for appendicitis under spinal, the other, after a rectal and ether anesthesia during the course of delivery. The first case showed radiologic evidence of a cervical rib on the affected side. The trauma in both of these cases was attributed to faulty position while under the anesthesia with resultant injury to the brachial plexus. Only five patients could be classified as the so-called "anatomic type," namely, long neck and sloping shoulders. Of these, one case showed an abnormal first rib.

Symptoms.—The duration of symptoms varied from six weeks to 11 years, with 10 of the 21 cases being seven months or less. The symptoms were variable, and except for the more prominent objective signs in those cases having cervical ribs, were in general essentially the same. The most consistent symptoms were pain, numbness, tenderness on pressure over the

scalenus anticus muscle, slight to marked muscular weakness, and occasional atrophy, with disability chiefly due to the increased pain on motion of the extremity rather than weakness. In addition many of the cases presented inhibited or lost tendon reflexes and diminution of cutaneous sensibility.

Pain.—Pain of variable intensity and dull aching in character was the most constant and prominent feature in all except one case. It was characteristically worse at night in 18 cases. The shoulder was the most frequent location of pain, generally over the posterior aspect, with 12 of the cases presenting this as the initial symptom. Pain occurred over the side of the neck in eight cases, arm six, forearm two, arm and forearm three, median distribution of the hand in four and ulnar side in three patients. In the majority of the patients the use of the affected extremity was limited due to the increased intensity of pain on motion. Extension and abduction of the arm in most instances increased the pain. The characteristic attitude was one of adduction of the arm and flexion of the elbow. The most comfortable position at night was similar, with the arm supported on a pillow.

Numbness.—Paresthesias, chiefly numbness, occurred in 12 cases; two of the latter were associated with tingling and two with a sensation of coldness. In four patients the numbness extended over ulnar distribution of the hand and in three instances over the median area. In one case the entire hand was involved and in another both hands.

Scalenus Tenderness.—Increased tenderness over the scalenus anticus muscle was demonstrated in all cases ranging from moderate to intense pain on pressure.

Weakness and Atrophy.—In 14 cases there was a slight to moderate weakness of the affected arm or hand. In the three cases showing symptoms on both sides, a relative increased weakness was found in the arm having the greater pain. Atrophy was marked in two cases, one with cervical rib and the other without. Another case with a cervical rib showed atrophy of the arm and gangrene of the forearm. One patient with an abnormal first rib had considerable atrophy of the hand with trophic changes in the fingers. In the remaining cases it was infrequently observed, and only slight if present.

Reflex and Sensory Changes.—Of the 18 cases in which a neurologic examination was made, seven showed changes in the reflexes on the affected side. The triceps reflex was absent in four instances and diminished in two. The biceps reflex was absent in two cases and diminished in one. The supinator reflex was similarly diminished in one instance and lost in two. Operation was followed by a return of function of the inhibited reflexes and partial restoration of those lost, except in two cases where the loss of activity has persisted. Sensory changes, characterized by diminution of pain and temperature sensation, occurred over the cutaneous distribution of the median nerve in four cases, the ulnar in two and both sides in three instances.

Neuroses.—In eight of this series there was an associated neurosis. It is interesting to note that there was a definite improvement in the clinical picture of "neurosis" in three of five patients, following operation with relief

of pain. The possibility of an associated neurosis causing a distortion of the typical clinical picture of the scalenus anticus syndrome should be borne in mind.

Vascular Changes.—Of the 18 cases in which blood pressure readings were recorded in both arms, six patients showed a decrease, averaging 15 points, and five showed an elevation of the blood pressure reading, averaging eight points on the affected side. In the majority of instances, the radial pulse could be obliterated or greatly diminished by having the patient turn the head toward the involved side and take a deep breath, or by deep pressure over the insertion of the scalenus anticus muscle. Neither of these tests, however, was considered of great significance, in that they can be demonstrated in asymptomatic cases. A distinct bruit was heard in the supraclavicular fossa of three patients. Three cases, showing advanced changes attributed to compression of the subclavian artery, deserve special comment. In one patient with bilateral symptoms a loud bruit could be heard over the supraclavicular fossa on both sides. The right radial pulse was almost imperceptible. Blood pressure was 90/70 on the right and 120/70 on the left side. At operation both subclavian arteries were found to be markedly constricted and sclerosed. There was no other evidence of circulatory disease. The bruits have persisted. The patient was completely relieved of symptoms, and an arthritis of the left shoulder, attributed to atrophic changes from prolonged disuse, cleared up rapidly. In another case in which symptoms on the left side were associated with bilateral cervical ribs, there was an absence of pulse and blood pressure readings in the affected arm. At operation the subclavian artery was found to be small and sclerotic. The scalenus anticus muscle was tremendously hypertrophied. Immediately after operation, blood pressure reading in the affected arm was found to be 80/60 and a faint pulsation could be palpated over the radial artery. The third case presented a complete obliteration of the subclavian artery with resulting gangrene of the forearm. Because of the striking clinical course it is presented in detail:

Case Report.—Extensive gangrene of hand and forearm resulting from compression of subclavian artery between the scalenus anticus muscle and a cervical rib.

A. J., colored, male, age 32, was admitted to the Surgical Division, Section A, Hillman Hospital, April 19, 1938, with gangrene of left hand, associated with severe pain. Present illness began eight years ago with pain in left arm and hand which disabled him for work at intervals. Seven months before admission, he developed severe pain and gangrene of the left middle finger. Gangrene gradually spread to involve the entire hand. Pain had been severe for the past two months, made worse by lying in a prone position. Examination revealed gangrene of left hand with a foul smelling discharge. There was atrophy of muscles of left arm, absent pulsations in left upper extremity and diminished temperature in left arm. Blood pressure in right arm 160/90, temperature 101° F., pulse 90. A bony prominence could be palpated in left supraclavicular fossa. The patient left the hospital two days after admission. He returned, August 15, 1938, with an extension of gangrene up to a point just below the left elbow. The middle third of the left ulna and radius was exposed. Motion was good in left elbow. There was marked atrophy of the left arm and shoulder girdle (Fig. 1A, B and C). Roentgenologic examination revealed bilateral cervical ribs, the left being incomplete and attached to the

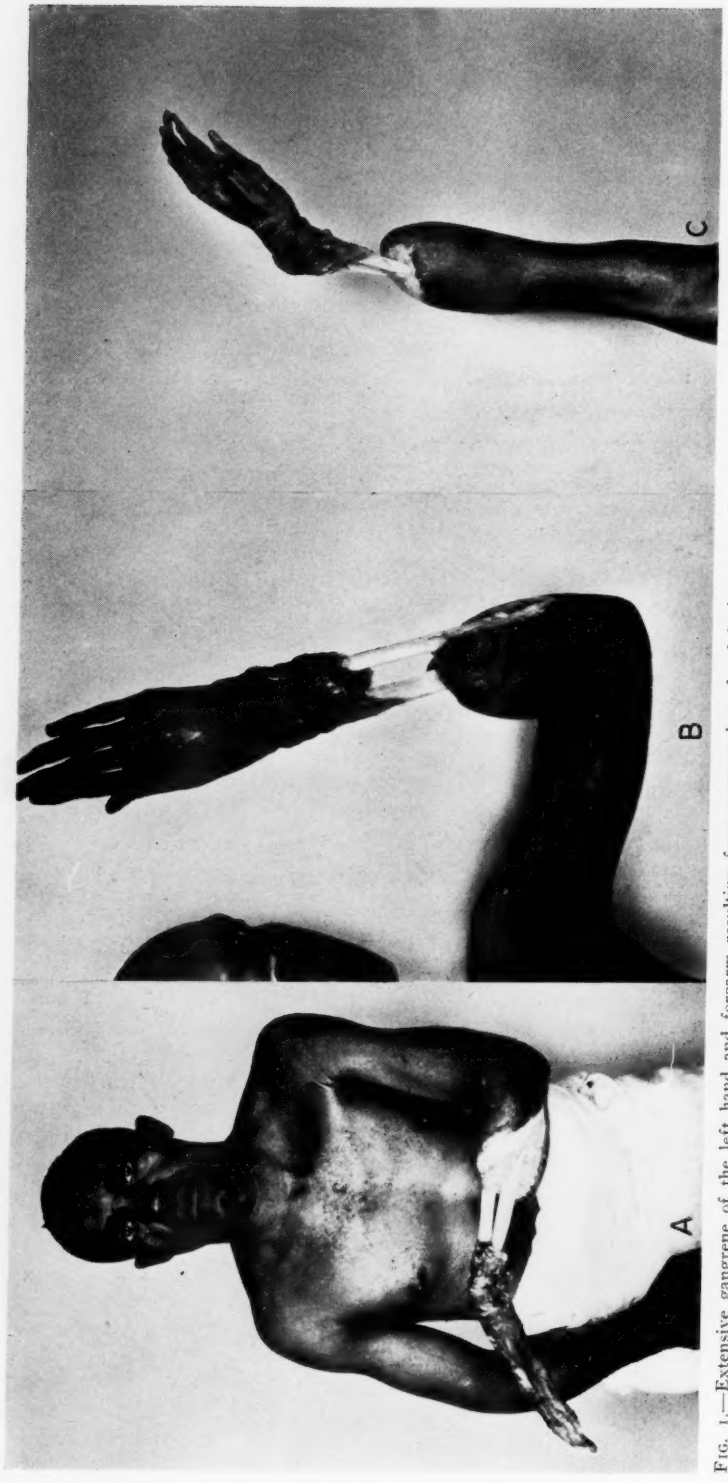


FIG. 1.—Extensive gangrene of the left hand and forearm resulting from compression of subclavian artery between the scalenus anticus muscle and a cervical rib. Bilateral cervical ribs were present.

first rib (Fig. 2A and B), and a fracture of the left ulna and radius at the line of demarcation below the elbow (Fig. 3). This was apparently spontaneous, as there was no history of trauma. On August 18, 1938, the left forearm was amputated under

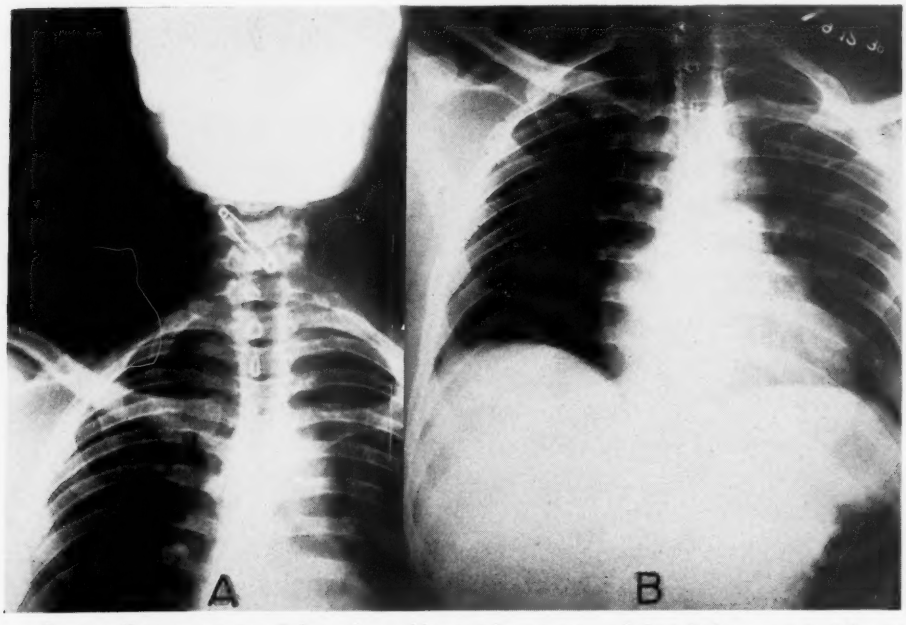


FIG. 2.—Roentgenograms of the patient with extensive gangrene of the left forearm. A. Bilateral cervical ribs—right complete, left incomplete and attached to the first rib. B. The distal portion of the left cervical rib has been removed—relieving pressure on the subclavian artery and brachial plexus.

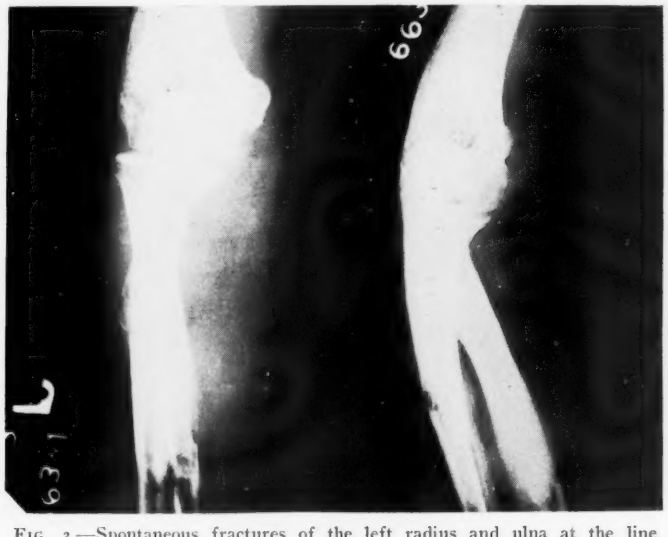


FIG. 3.—Spontaneous fractures of the left radius and ulna at the line of demarcation of the gangrene.

sodium pentothal anesthesia. As much of the soft tissue as possible was conserved. There was no pulsation in radial or ulnar arteries at their origin. Collateral circulation appeared to be good. Six days later a tenotomy of left scalenus anticus muscle and

resection of distal portion of left cervical rib was performed, again using sodium pentothal anesthesia. The scalenus anticus muscle was not hypertrophied. This procedure did not completely relieve pressure on the subclavian artery and brachial plexus which were pushed forward from behind by the cervical rib, causing the artery to be flattened out and completely obliterated. No pulsation could be demonstrated distal to the rib. The artery was smaller than normal where the scalenus anticus muscle crossed it. The rib was partially removed allowing the structures to resume their normal position.

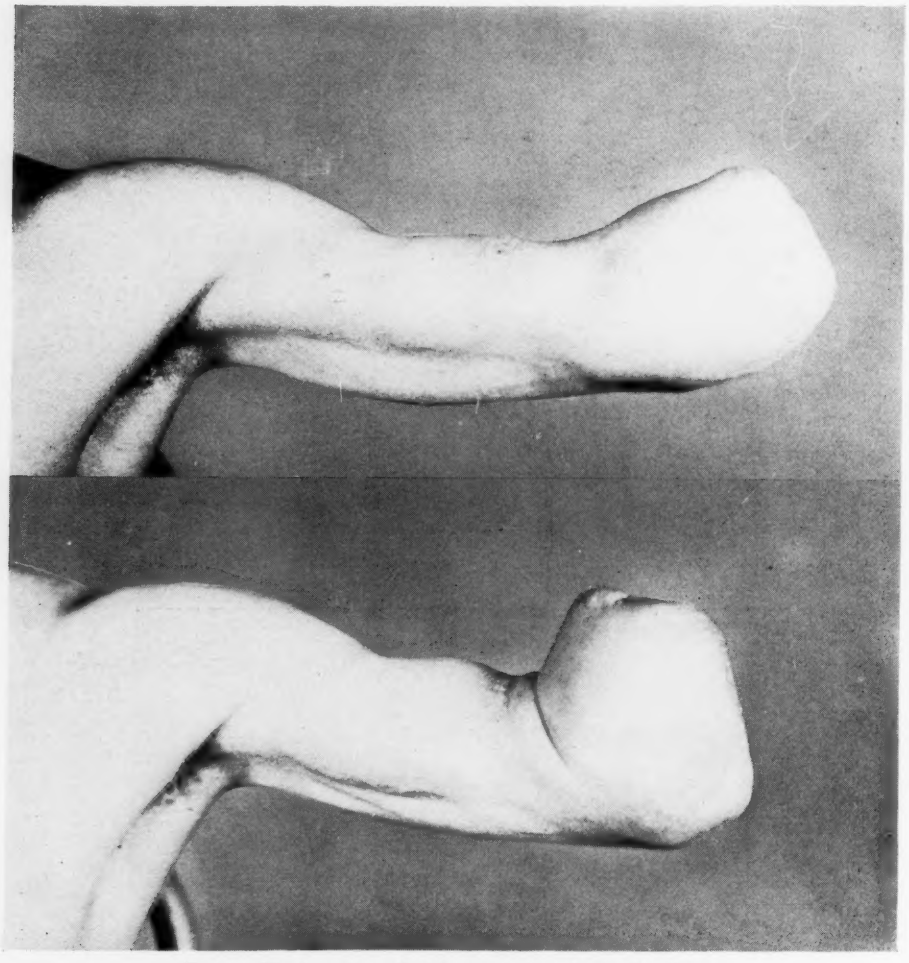


FIG. 4.—Final result; patient has normal motion in the elbow.

Pulsation was questionable after the compression was relieved. The amputated stump of the forearm healed completely in 17 days. Pulsation in the left brachial artery was obtained soon after operation. The patient has since remained well and free of symptoms (Fig. 4). He has worked regularly as a truck driver with the use of an artificial arm.

It was thought that absence of definite hypertrophy and tenseness of the scalenus anticus muscle usually observed in these cases was apparently due to an advanced stage of the syndrome when all the muscles of the left shoul-

der girdle and arm had become atrophic. This case typifies those rare instances in which the rib must be removed in addition to tenotomy of the muscle to relieve compression.

Roentgenologic Examination.—Bilateral cervical ribs were demonstrated in three patients. Of these, two presented symptoms on the left side; one, a colored female, with absence of radial pulse and blood pressure reading on the affected side (Fig. 5 A and B), and the other, a colored male mentioned above, with an extensive gangrene of the forearm. The third patient, a white female, showed symptoms on the right, with a Horner's syndrome

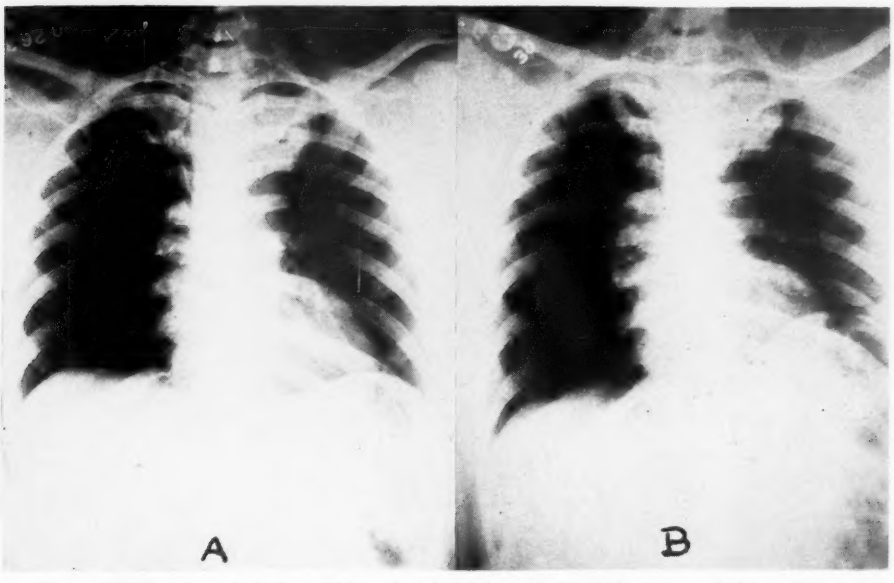


FIG. 5.—Bilateral cervical ribs. This patient had left syndrome with absence of blood pressure and pulse in left upper extremity. A. Before scalenotomy. B. After scalenotomy, showing elevation of left diaphragm due to temporary paralysis from traction on left phrenic nerve at time of operation.

on the affected side. One case showed a right cervical rib with extensive symptoms in right arm simulating syringomyelia (Fig. 6). Another patient with bilateral symptoms was found to have an abnormal first rib on the side showing the more marked symptoms (Fig. 7). In the 16 remaining cases there was no evidence of supernumerary ribs. The symptoms in these cases were essentially the same as in those with cervical ribs, except that the objective findings were less marked. It should be emphasized that cervical ribs, when bilateral, may offer a real difficulty in roentgenologic diagnosis unless one is looking for the anomaly. It may be necessary, at times, to get a complete picture of the chest to show all the ribs before we can be certain of the diagnosis.

Operative Procedure.—The operative technic was essentially that described by Adson and Coffey,[2] and Ochsner, *et al.*[8] A 1 per cent novocain infiltration was employed in 11 cases, sodium pentothal in three, cyclopropane in one, and nitrous oxide in one. It should be borne in mind that the scalenus anticus

muscle is deeply situated. It can be palpated beneath the overlying fat pad which is a good guide to exposure. The muscle is easily identified by the phrenic nerve which passes obliquely across it from the lateral surface medially. After the muscle has been exposed it is sectioned in layers through the tendinous attachment. A blunt pointed aneurysm needle lends itself well to this procedure. It is passed through only parts of the muscle at a time from the medial surface laterally. The subclavian artery comes forward into view in most instances after all fibers of the muscle have been divided.

We have found it quite easy to go too far medially in getting down to the muscle. In one case of left scalenus anticus syndrome the thoracic duct was

FIG. 6.—Right cervical rib (posterior view). This patient presented extensive atrophy of the right hand and arm, simulating syringomyelia.

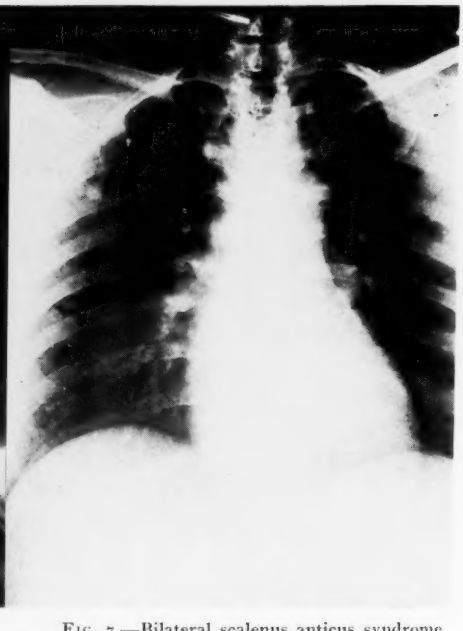


FIG. 7.—Bilateral scalenus anticus syndrome in a patient with an incomplete first dorsal rib attached to the second dorsal rib causing a prominence in the left supraclavicular fossa.

accidentally lacerated. The wound rapidly filled with clear lymph, the patient having fasted for 12 hours before the operation. The accident was discovered at the time and the thoracic duct was ligated. No symptoms developed as a result of ligation of the duct and the patient made an uneventful recovery. Silk was used in 13 of the cases and catgut in three. We feel that silk is definitely superior to catgut in these cases because of minimum tissue reaction following its use. No drains were used in any of the cases.

Spurling and Bradford[9] call attention to the temporary paralysis of the diaphragm in these cases following traction on the phrenic nerve and advise against bilateral tenotomy of the muscle in one stage. We confirmed this observation in each of four cases in which fluoroscopic and roentgenologic examinations were made (Fig. 8 A and B). In the three cases of bilateral syndrome in our series, however, both muscles were sectioned at one time

with no apparent after-effect. Craig and Knepper[10] have previously reported cases in which bilateral scalenotomy was performed at one operation.

Pathology.—In all cases, except the one with extensive gangrene and wasting of the muscles of the neck, shoulder and arm, the scalenus anticus muscle was found to be hypertrophied and tense. In some cases the hypertrophy was more marked than in others and bore a definite relationship to severity of symptoms. Specimens of nine sectioned scalenus anticus muscles were examined microscopically. The changes were, in general, insignificant. Small scattered areas of fibrosis were found in three cases. One of these showed a prominent thickening of the arterioles. Two other cases had moderate arteriosclerotic changes. The histologic picture of the others was essentially negative.

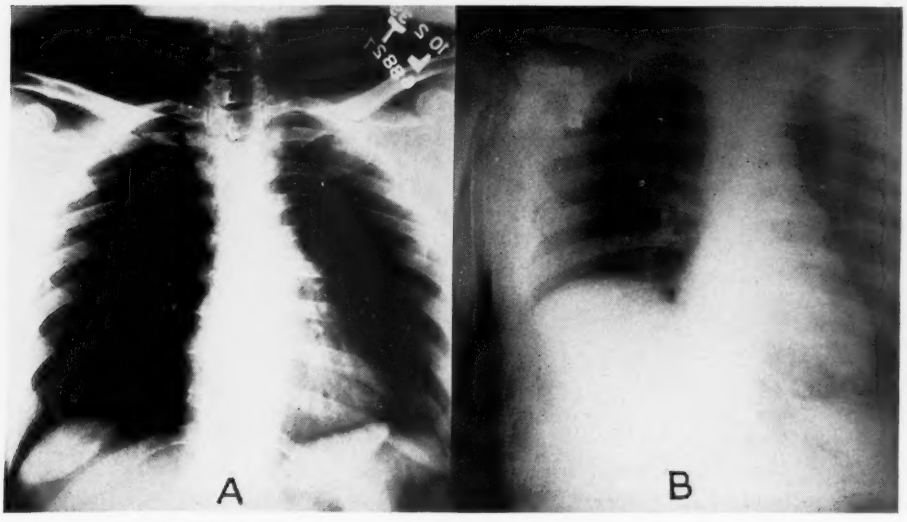


FIG. 8.—A. Elongated seventh cervical transverse processes, especially the right, in a patient with right scalenus anticus syndrome. B. Elevation of right diaphragm following scalenotomy due to traction on phrenic nerve.

Operative Results.—Of the 16 cases submitted to operation, 14 have been completely relieved of all symptoms. The relief of pain immediately followed section of the muscle in nine patients, and in three instances complete relief was obtained before leaving the hospital, the average stay being four to five days. In one case symptoms persisted for one week after leaving hospital, in another, complete relief was obtained two weeks after the operation, and in a third, mild symptoms persisted for six weeks after tenotomy. In the two cases showing recurrence of symptoms, one developed seven months after operation, following excessive use of the affected arm. Symptoms persisted for a period of two months before gradually subsiding. In another case, operated upon one year ago, mild pains at infrequent intervals have persisted since resumption of her previous occupation as a domestic servant.

Mild (Nonsurgical) Cases.—In addition to the above reported cases, 19 patients were examined who were considered as having symptoms of a mild

scalenus anticus syndrome, in which surgery was not indicated. Their ages ranged from 16 to 47 years, with an average of 35 years. Of these, 15 occurred in the fourth and fifth decades. There were 13 females and six males. Symptoms were present on the right side in six cases, left six, and were bilateral in seven. Of those showing symptoms on both sides, the left side was more prominently affected in four cases. Pain, aching in character and subject to remissions, was found in all cases. It was worse at night in six patients, the most frequent location being, in order, the shoulder, neck and arm. A sensation of numbness was present in nine instances and coldness

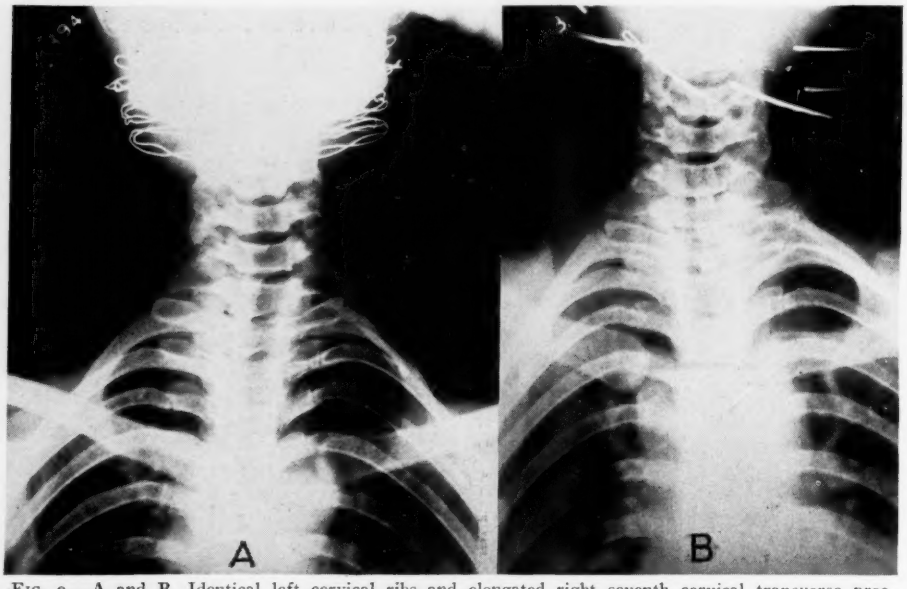


FIG. 9.—A and B. Identical left cervical ribs and elongated right seventh cervical transverse processes in identical twin females, with mild symptoms in their left arms.

of the hands in two. The symptoms ranged in duration from one month to 15 years, with 12 being six months or less. Aside from the finding of a supraclavicular bruit in three cases, and increased scalenus tenderness in all instances, the objective signs were essentially negative. Of interest, was the presence of a supernumerary rib in identical twins, 32 years of age, each of whom showed roentgenologic evidence of a left cervical rib (Fig. 9 A and B). None of six other patients who had roentgenologic examinations in this series showed the presence of a supernumerary rib. One patient presented attacks simulating angina pectoris. Although the increased intensity of symptoms in some of these cases may eventually necessitate operative relief, approximately 60 per cent of them have shown a considerable improvement following symptomatic treatment and improvement of posture. A few have been completely relieved.

Discussion.—It is assumed that the scalenus anticus syndrome is found in patients having inherent anatomic and developmental variations about the shoulders, although this is frequently not demonstrable. It is well known

that symptoms are found more frequently in women, rarely before the age of 20, and that most cases occur between the ages of 20 and 40. Todd[11] attributed the development of symptoms to an abnormally low position of the shoulder and high fixation of the sternum and ribs. The shoulder girdle descends farther in women; therefore, it may be expected that the syndrome will be encountered more frequently in women. The so-called "anatomic type," mentioned by Freiberg,[12] characterized by sloping shoulders and long neck, was seen in but five of our 21 cases. The others presented no unusual external type. Jones[13] believed a low origin of the brachial plexus to be responsible for the development of symptoms. Ochsner, Gage and DeBakey[8] claim the exciting factor to be an elevation of the first rib due to spasm of the scalenus anticus muscle resulting from brachial plexus irritation. Gage[14] has been able to demonstrate a temporary relief of pain in three cases by the injection of a 1 per cent novocain solution into the scalenus anticus muscle. Freiberg[12] believes that the scalenus anticus syndrome occurs as a sequela of primary lesions of the shoulder joint and cervical spine more frequently than as an isolated clinical entity. He points out that the symptoms frequently disappear after local therapy to lesions of the cervical spine and shoulders. Although these significant factors must be borne in mind, it is interesting to note the clinical improvement of two cases of arthritis of the shoulder joint in our series associated with the scalenus anticus syndrome, following scalenotomy. Direct trauma preceding the onset of symptoms could be demonstrated in only one of our 21 cases. In two others the trauma was attributed to faulty position while under anesthesia, followed immediately by the development of symptoms typical of the syndrome. The frequency and importance of trauma, as a precipitating factor, has been stressed by Honeij,[5] Spurling and Bradford,[9] Naffziger and Grant,[15] and others. Excessive occupational strain, whether considered traumatic or responsible for a muscular imbalance of the shoulder, is also a significant factor, as demonstrated in eight of our cases. The reason for the preponderance of cases in our series in the fourth and fifth decades may possibly be attributed to regressive muscular changes occurring in the ages between 30 and 50 with resulting drooping of the shoulders. The characteristic increase of pain at night in the majority of the cases may be accounted for by the pressure from behind, as the shoulders are brought forward against the scalenus anticus muscle while in the prone position.

The symptoms of cervical rib and scalenus anticus syndrome are similar. In both conditions we are probably dealing with inherent anatomic and developmental variations which represent the fertile soil for the development of symptoms precipitated by such factors as trauma, occupational strain and improper posture. In our series of cases the more extreme brachial plexus and circulatory disturbances have been noted in patients with cervical ribs, suggesting that symptoms are apt to be more marked in the presence of a supernumerary rib. The symptoms result from compression or irritation of the brachial plexus and compression of the subclavian artery. Telford and Stop-

ford[16] attribute the vascular changes to irritation of the sympathetic fibers of the brachial plexus rather than to direct pressure on the artery.

In view of the fact that the scalenus anticus muscle is the primary factor in the production of neurocirculatory compression, regardless of whether a cervical or abnormal first rib is present, it would seem appropriate to group all of these cases under the term "Scalenus Anticus Syndrome" and designate whether a cervical rib or abnormal first rib is associated. The surgical indications are the same and results have usually been excellent. Indiscriminate scalenotomy in all cases exhibiting the syndrome is certainly not indicated, as many of the cases are mild and will respond to conservative therapy. It has been our experience that the symptoms in the milder cases are not progressive, but subject to remissions and exacerbations.

This study indicates that the symptoms of the scalenus anticus syndrome occur with much greater frequency without the presence of a cervical rib. The syndrome accounts for many cases of pain and unexplained vascular disturbances in the upper extremities. On account of the frequent gradual onset and bizarre picture present in some cases, it is often difficult to make a positive diagnosis. In some cases we have kept patients under observation for several months before any definite conclusions were made. A neurologic examination is urged in all cases. The conditions causing the most difficulty in the differential diagnosis have been: Infectious neuritis; arthritis of the shoulder joint; cervical arthritis; subacromial bursitis and neurosis.

SUMMARY AND CONCLUSIONS

(1) Twenty-one cases presenting symptoms of the scalenus anticus and cervical rib syndrome are reviewed.

(2) Sixteen cases were not associated with a cervical or abnormal rib, indicating that the scalenus anticus syndrome occurs with much greater frequency than the cervical rib syndrome.

(3) Although the symptoms of the scalenus anticus and cervical rib syndromes are similar, objective findings are apt to be more marked when associated with a cervical rib.

(4) The symptoms are the result of compression of the brachial plexus and subclavian artery by the scalenus anticus muscle.

(5) The symptoms are precipitated by such factors as trauma, occupational strain and improper posture in patients having inherent anatomic and developmental variations about the shoulders.

(6) In view of the essentially identical etiologic factors and clinical picture of the scalenus anticus and cervical rib syndromes, it is suggested that the term "Scalenus Anticus Syndrome" be applied to both conditions with the occurrence of a rib, if present, specified.

(7) The scalenus anticus syndrome appears to be more frequent than is generally recognized and is a common cause of brachial plexus neuritis and unexplained vascular disturbances of the upper extremities.

(8) The results following scalenotomy have been excellent. Fourteen of the cases have been completely relieved of symptoms. One has had a recurrence of two months' duration, seven months after operation; the other has complained of mild symptoms at infrequent intervals.

(9) Scalenotomy in all cases is not indicated as many are mild and respond to conservative therapy.

(10) Remissions and exacerbation of symptoms are characteristic of the mild cases.

REFERENCES

[1] Murphy, J. B.: The Clinical Significance of Cervical Ribs. Surg., Gynec., and Obstet., **3,** 514, 1906.

[2] Adson, A. W., and Coffey, J. R.: Cervical Rib; a Method of Anterior Approach for Relief of Symptoms by Division of the Scalenus Anticus. ANNALS OF SURGERY, **85,** 839, 1927.

[3] Cited by Brickner, W. M., and Milch, H.: First Dorsal Simulating Cervical Rib—by Maldevelopment or by Pressure Symptoms. Surg., Gynec., and Obstet., **40,** 38, 1925.

[4] Stopford, J. S. B., and Telford, E. D.: Compression of the Lower Trunk of the Brachial Plexus by a First Dorsal Rib. Brit. Jour. Surg., **7,** 168, 1919.

[5] Honeij, J. A.: Cervical Ribs: Presentation of Cases and a Bibliography. Surg., Gynec., and Obstet., **30,** 481, 1920.

[6] Carroll, W. C.: Cervical Ribs and Abnormal First Thoracic Ribs. Minn. Med., **15,** 828, 1932.

[7] Adson, A. W.: Surgical Treatment of Cervical Ribs. Texas State Med. Jour., **28,** 739, 1933.

[8] Ochsner, A., Gage, M., and DeBakey, M.: Scalenus Anticus (Naffziger) Syndrome. Am. Jour. Surg., **28,** 669, 1935.

[9] Spurling, R. G., and Bradford, F. K.: Scalenus Neurocirculatory Compression. ANNALS OF SURGERY, **107,** 708, 1938.

[10] Craig, W. McK., and Knepper, P. A.: Cervical Rib and the Scalenus Anticus Syndrome. ANNALS OF SURGERY, **105,** 556, 1937.

[11] Todd, T. W.: The Descent of the Shoulder After Birth; Its Significance in the Production of Pressure Symptoms on the Lower Brachial Plexus. Anat. Anz., **41,** 385, 1912.

[12] Freiberg, J. A.: The Scalenus Anticus Muscle in Relation to Shoulder and Arm Pain. Jour. Bone and Joint Surg., **20,** 860, 1928.

[13] Jones, F. W.: On the Relation of the Limb Plexus to the Ribs and Vertebral Column. Jour. Anat. and Physiol., **44,** 377, 1909.

[14] Gage, M.: Scalenus Anticus Syndrome; A Diagnostic and Confirmatory Test. Surgery, **5,** 599, 1939.

[15] Naffziger, H. C., and Grant, Wm. T.: Neuritis of the Brachial Plexus Mechanical in Origin. The Scalenus Syndrome. Surg., Gynec., and Obstet., **67,** 722, 1938.

[16] Telford, E. D., and Stopford, J. S. B.: The Vascular Complications of Cervical Rib. Brit. Jour. Surg., **18,** 557, 1931.

THE CERVICOBRACHIAL SYNDROME *

A DISCUSSION OF THE ETIOLOGY WITH REPORT OF TWENTY CASES

KENNETH H. AYNESWORTH, M.D.

WACO, TEX.

NAFFZIGER,[39] in a recent paper, clearly limits the scalenus syndrome to cases suffering from neuritis of the brachial trunks. However, since there are a number of pathologic conditions besides the compression of the scalenus anterior muscle which may produce identical symptoms, the Naffziger terminology, therefore, is too limited.

The vascular and nerve trunk symptoms should be expressed in a more inclusive terminology. The term "cervicobrachial syndrome" does not define the diseases but it does give a comprehensive and an anatomic concept which is accurate and inclusive.

The 20 cases included in the paper comprise 12 of my own and eight cases which occurred in the practice of my colleagues in the Providence Hospital. All of these cases have come under my observation before operation and the diagnosis was confirmed either by operation or by subsequent history. My cases include four which were operated upon by me for cervical rib prior to the understanding of the rôle which the scalenus anterior muscle exercises in the symptomatology or in the pathology.

The first case, seen in 1914, was a male railroad employee, who was injured in a wreck by falling on the left shoulder. Subsequently, the left arm became very painful, swollen, useless, and obliged him to stop working. He complained of severe pain in the left shoulder and left arm, especially in the medial side, pain and stiffness in the little and ring fingers, *etc.* Roentgenologic examination showed bilateral cervical ribs; the left was a complete rib articulating with the first rib; in the supraclavicular fossa was a hard, tender, slightly pulsating mass, which, he claimed, caused intense pain down the inner side of the arm. Accurate records were not made at the time. The diagnosis was neuritis of the branchial plexus, especially the lower trunks, due to the injury. Resection of the left cervical rib by the old technic relieved the symptoms. It was several months before the patient returned to his regular occupation. This was clearly a case due to traumatism. The other three cases gave similar histories, as all of them were injured by falling on or by being struck on the shoulder. Their histories offer no additional interest as they were treated by removal of the affecting cervical rib and were diagnosed as cervical rib cases. Two of these patients were under observation until they returned to their regular duties several months later; the other patient was not observed and the results are not known. All of them gave histories of having been well and regularly on duty as railroad laborers before the injury.

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

The other 16 cases have come under observation since the rôle of the scalenus anterior muscle has been suggested by a number of writers. Every case has been studied carefully and ten cases confirmed by operation, with relief of symptoms, except one case which had only partial relief. In all of the cases not operated upon, the same diagnostic criteria were insisted upon to make the diagnosis as were those operated upon. Roentgenologic examinations confirmed the presence of cervical ribs, when present; the neurologic and vascular examinations elicited the same findings as those who were operated upon.

The following type-cases are reported to illustrate the theories of the etiology and the course of the ailment. All of them gave a history of traumatism.

ILLUSTRATIVE CASE REPORTS

Case 1.—*The Neurologic Type:* A female, age 65, had always been in fairly good health, except that she had suffered during recent years from multiple arthritis associated with high blood pressure.

In October, 1935, she fell down the stairway and struck the left shoulder and the left side of the body; she felt very sore and bruised for a few days. About four weeks later, she drove an automobile to Michigan. She then began to suffer from a dull, aching pain in the *right side* of the neck. The pain became severe within a few days, especially at night. A few weeks later, the pain had spread into the shoulder and down into the arm, forearm and hand, and up the side of the neck. She noticed swelling and tenderness as well as pain in the entire arm, but more severe in the inner side of the entire arm and hand. The pain was more severe in the shoulder and upper arm. She felt numbness, tingling and tenderness of the skin, which was slightly cyanotic. She noticed disturbed tactile sensations, especially in the hand, but most marked on the ulnar side and in the little and ring fingers. She now had a constant ache in the arm and kept it in a sling strapped to her side. She consulted a physician in January, who first strapped the arm firmly to her side, which gave no relief; then he applied a Velpeau splint, which gave no relief, and the shoulder joint became quite stiff. Then baking and diathermy were used, with no benefit.

Physical Examination.—The patient is a rather stout, well-nourished woman with the right arm carried in the left hand. She complains on the least movement of the right arm. It is moderately swollen below the elbow, especially the hand and fingers; the skin is dusky and definitely cyanotic and pits on pressure. The arm is held close to the body, the elbow is flexed and the hand about half closed. Any movement of the joints is painful. The pulse varies from 80 to 90; the blood pressure in the right arm is 150/90 and 160/90 in the left arm. There is a definite pulsating swelling in the right side of the neck along the line of the carotid artery which has been diagnosed as an aneurysm. There is moderate tenderness in the supraclavicular fossa, but no mass is palpable. With head erect and turned to the right, pulsation in the right radial artery was absent. All reflexes in the arm were normal. Roentgenologic examination showed no cervical rib on either side. The diagnosis was scalenus anterior syndrome. At operation, the scalenus anterior muscle was severed from its attachment to the first rib according to the technic of Adson.[16]

Comment.—The scalenus anterior muscle was greatly enlarged, somewhat fibrous, and apparently tenser than normal. About one-half inch of the muscle was removed. The attachment of the lateral fibers of the scalenus anterior was very broad and fibrotic. When the muscle was cut through and one-half inch removed, it contracted and the subclavian artery rose up in a wide curve over the first rib and seemed to expand in

size. The two lowest nerve trunks were carefully freed from a small amount of fibrous tissue.

Postoperative Course.—The recovery from pain was noted the afternoon of the operation and within a week the patient was discharged. Since then she had been well.

This report gives a succinct history of injury by *indirect* force to the scalenus anterior muscle which resulted in muscular contraction which compressed the lower nerve trunks and caused the symptoms outlined above. There was no cervical rib or pressure on a normal first rib which would produce the symptoms which were presented.

Case 2.—*The Vascular Type*[9]*:* A female, age 44, was examined May 31, 1938; she had always been in good health, except for typhoid fever at age 17. She had noticed a painless, but pulsating swelling in the right supraclavicular fossa about ten years previously, following a very difficult and prolonged labor, during which she felt a very severe, cutting pain in the right side of the neck while she was pulling on obstetric straps. She complained of soreness and tenderness in the right side of the neck for some weeks, especially when she would turn her head.

The swelling in the neck gave no trouble, although it had slowly increased in size until about eight months ago when she began to have tingling pains in the swelling which rapidly radiated into the shoulder, the entire arm, hand and fingers, but was felt more in the inner side of the arm and hand and in the little and ring fingers, although the whole hand was affected. The fingers and hand became cold and numb. Although the pain was always a more or less severe aching, worse after using the arm, it changed at times from the side of the neck to the shoulders, elbow, *etc.* She complained of dizziness, right-sided headache, and "roaring" in the head at times. The pain was constant day and night. Her physician had told her she had no right pulse.

She had consulted several physicians who administered roentgen therapy, diathermy, *etc.*, but with no relief. The pain had become more severe and the arm almost useless during the last few weeks.

Physical Examination.—The patient was of a rather fleshy, stout type and appeared to be in good health, but supported the right arm in the left hand. Temperature normal; left pulse 70; the right hardly perceptible, but 70. The blood pressure 142/70 in the left arm; it could not be ascertained in the right arm because of instant pain from the arm band and the arm became very cyanotic. There was no edema and very little tenderness except over the olecranon which was hypersensitive. There was a visible, tender, pulsating mass in the right supraclavicular fossa about 5 cm. in size which extended beneath the clavicle. She was most comfortable with the arm hanging down. Roentgenograms showed bilateral cervical ribs. The patient refused treatment.

Examination One Week Later.—The blood pressure in the left arm was 142/74; *the right pulse could not be felt.* She now complained of greater pain in the shoulder neck, and in the right side of the head. The pulsating mass in the right supraclavicular fossa had not changed. The laboratory findings are normal; Wassermann test negative. Roentgenologic examination by another laboratory confirmed the diagnosis of bilateral cervical ribs; the left one was small; the right one was large, complete, and articulated with the first rib in front (Fig. 1). The diagnosis was: (1) Aneurysm of the right subclavian artery; (2) bilateral cervical ribs; (3) neuritis of the right brachial plexus, lower two trunks. Removal of the right cervical rib and section and removal of one-half inch of the scalenus anterior muscle were effected.

Comment.—The Adson incision was employed. The arterial swelling was an aneurysm about one inch long and one inch in diameter, which was definitely limited distally beneath the clavicle, which was lying close to the first rib. When the scalenus anterior muscle was severed, the artery rose up into a rather high arch across the

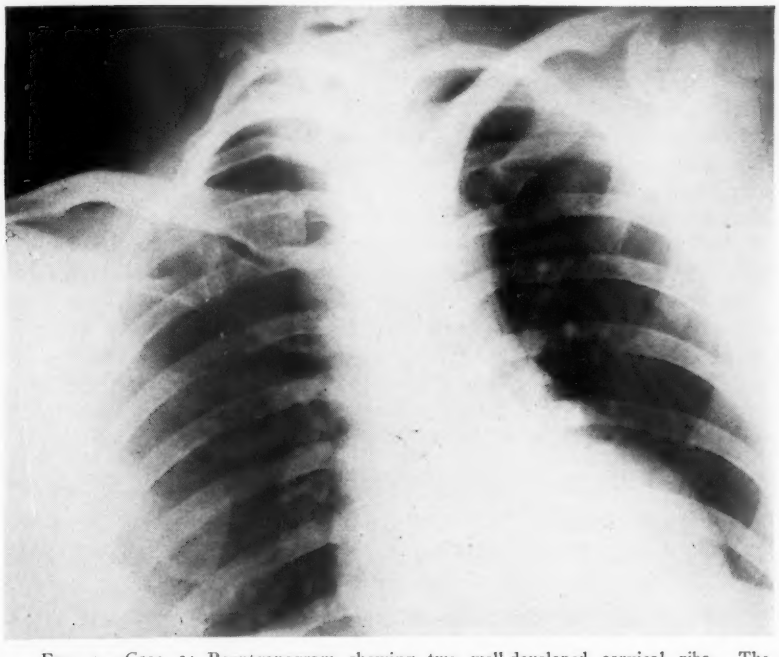


FIG. 1.—*Case 2:* Roentgenogram showing two well-developed cervical ribs. The left one is short and does not articulate with the first rib. The right one is very large, long, and articulates with the first rib.

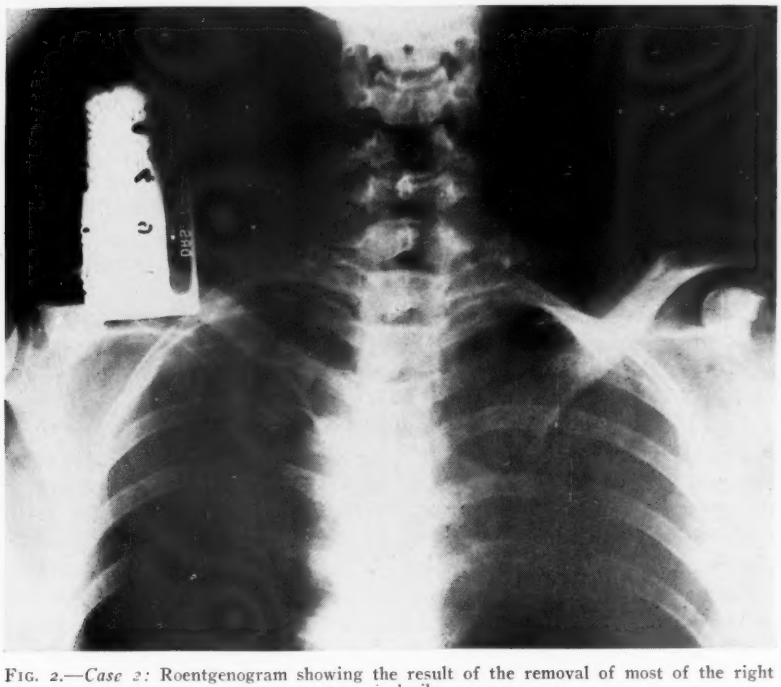


FIG. 2.—*Case 2:* Roentgenogram showing the result of the removal of most of the right cervical rib.

fossa but there was still obstruction to it as it crossed the cervical rib. When the cervical rib was removed (Fig. 2), the aneurysmal artery formed a smaller arch than before the rib was removed, as its distal end lay lower. The scalenus anterior muscle was not enlarged but had a wide attachment and cut like fibrous tissue, with wide retraction of the upper end which furnished more space for the dilated aneurysmal artery. The scalenus medius appeared to be fibrous but it was not incised. The wall of the aneurysm did not show any areas of calcification or other degeneration, although they were carefully searched for.

Subsequent Course.—The patient has made a most satisfactory recovery. Six months later, she had, as residual effects, some stiffness of the shoulder, inability to elevate the arm above the chin, but she had no pain, no limitation of arm movements below the level of the shoulder; and the pulse had returned. The mass in the supraclavicular fossa was apparently smaller and the pulsations were not noticed by the patient.

Follow-Up.—November 29, 1939: She can use the arm in any position with no discomfort. The right hand is normal; it feels colder than the left. There is no pulse appreciable in the right radial artery. Blood pressure in the right arm 104/88; left 144/96. There is no pulsation in the supraclavicular fossa.

Comment.—This case was probably due to traumatism, during labor, to the scalenus anterior muscle resulting in fibrous tissue formation and contraction over a long period of time. In this case the vascular symptoms were definite and were relieved by resection of the tense scalenus anterior muscle and the removal of the obstructing cervical rib. The results have been the relief of all of the symptoms although the aneurysm has decreased in size only slightly. The aneurysm was not removed because the vessel walls did not appear to be seriously diseased and it was thought that the vascular symptoms would be relieved by the operation.

Case 3.—*Traumatic Neuritis Type:* A physician, age 50, said that he had always been in good health until December 2, 1938, when he fell from the top of a seven-foot fence, landing on his right shoulder on a brick pavement; he had severe pain in and around the right shoulder for several days following the injury. After one week the pain and soreness subsided and for six weeks he suffered no inconvenience. During the latter part of January, or during the first week of February, he began to have pain in the right deltoid region, in the shoulder, over the flexor surface of the right elbow joint and slight pain down the flexor surface of the arm to the wrist joint. It was moderately severe, but constant. He continued to drive his car, but the pain was serious enough to keep him awake at night. After this pain had been present for about two or three weeks, while running, he again fell, striking the point of the right shoulder against the ground. Following this, the pain became rapidly worse. He consulted Dr. E. P. Bunkley, of Stamford. The patient continued with his duties although he had employed a chauffeur during the last few weeks.

He kept the arm in complete adduction constantly with the forearm flexed to a right angle, with the hand lying across the abdomen; the hand and fingers were edematous and the right arm was one-half larger than the left. Any voluntary movements of the arm, except in the anterior position, caused extreme pain in the arm and shoulder; this was especially marked when the arm was voluntarily abducted or moved backwards. He had radiating pains through the right side of the neck and into the shoulder when the head was rotated to the right side with the chain extended. There was partial skin paresthesia over the whole detoid region, the anterior surface of the arm, over the flexor surface of the elbow joint, and down the surface of the forearm to within two or three inches of the wrist joint. The examination otherwise was negative.

About the middle of April, the patient was seen in consultation. Examination confirmed the above history and findings. There was a definite, hard, tender area in the right supraclavicular fossa but no pulsation. The hand and forearm were edematous and tender over the whole area of the region of pain. He held the arm in flexion, adduction, and flexed across the abdomen. There was no change in the pulse in either arm; there was marked tenderness over the distribution of the fifth, sixth, and seventh cervical nerve trunks.

Roentgenologic examination showed bilateral cervical ribs, arthritis of the cervical spine, and a destructive process in the third thoracic vertebra, probably due to an old injury. A diagnosis of scalenus anterior syndrome, due to injury, associated with cervical ribs, was made. Section of the scalenus anterior muscle by Doctor Bunkley confirmed the diagnosis. The relief from pain and soreness was immediate. Recent reports indicate that he still has some tenderness in the deltoid region and moderate pain in the arm at times. This may be due to regeneration of some fibers of the scalenus anterior muscle or some unsectioned fibers.

COMMENT.—The connection between traumatism and the scalenus anterior syndrome is rather convincing in this case. The results of the operation are additional proof of the theory. This case illustrates the traumatic etiology due to indirect injury to the scalenus anterior muscle. While there was a cervical rib present, it produced no pressure upon the brachial plexus until the injury to the shoulder and the section of the scalenus anterior muscle gave immediate and permanent relief. This patient is a physician and he had observed the progress of the symptomatology from the beginning of his ailment. There were no vascular symptoms. The traumatism in this case, as in all of the others, was not directly to the scalenus anterior muscle although it must have caused violent stretching and consequent fibrous tissue formation and contraction within the muscle fibers. The theories of Todd,[45] Jones,[43] and others based, as they are, upon embryologic defects, if true, offer a clue to the disturbance caused by injury to the scalenus anterior muscle. As long as the scalenus anterior muscle could perform its normal function, even though the plexus was postfixed or anteriorfixed, or the shoulder was lowered and the area covering the apex of the lung was contracted, there would be no symptoms of scalenus anterior compression. But, in these embryologically defective patients, a slight change in the normal relationship in the region of the plexus or the subclavian artery as it passes through this space or over the cervical or normal rib, would produce compression and symptoms of nerve injury, or vascular compression would arise.

Case 4.—*The Neurologic Type:* A housewife, age 35, mother of two children, always very nervous, had had a tonsillectomy, and a supravaginal hysterectomy for tumors, but never any serious, acute illness. A sufferer from serious periodic headaches, she was in a car wreck two years ago which threw her head violently backwards and left her with soreness in the neck, right shoulder and arm. These symptoms improved, but she remained very nervous and highly emotional. She has had, during the years, many examinations, including spinal puncture and other neurologic procedures. In December, 1937, about one year after the accident, she began to have severe headaches localized in the occipital region, diffusing over the head, and into the right side of the neck, during which she would be nauseated and would vomit. She had no fever. Shortly thereafter, she began to have severe pain in the right side of the neck, in the right shoulder, and in

the arm, but more intense on the inner side along the distribution of the ulnar nerve, with acute skin tenderness. At times, there was numbness of the fingers and hand. She did not have constant pain in the right arm, but she did have a number of similar spells frequently during the next two years. She was employed as a bookkeeper and tried to continue, but the pain in the right arm and the hand prevented. About one month before examination an attack came on which has not subsided. She has, also, pain in the left side of the head and some left cervical tenderness when the headaches are most severe or continue for any length of time.

FIG. 3.—*Case 4:* Roentgenogram showing a well-developed, right cervical rib which does not articulate with the first rib—this is very indistinct in this reproduction, but is readily identified in the original roentgenogram.

Examination disclosed bilateral cervical ribs with definite arthritis of the cervical spine (Fig. 3). A few days later, she had an acute attack of severe pain in the occipital region, radiating into the right side of the neck, into the right arm and forearm and hand; the distribution of the ulnar nerve was definitely and directly affected; although she complained of pain in the entire arm, it was mild and not definitely defined as was the ulnar pain. There was no skin anesthesia or paresthesia. Predicated upon this history and examination it was believed that there was sufficient evidence of pressure upon the lowest nerve trunk to justify an operation. The scalenus anterior muscle was sectioned with relief of all of the symptoms referred to the distribution of the ulnar nerve.

Subsequent Course.—She did quite well for some time, but the spells of severe occipital headache returned with both greater intensity and frequency, with extension of the spinal pain to the thoracic region. She was treated by another physician for this with a plaster spinal splint, rest in bed for weeks and liberal use of endocrine drugs. She was not benefited. Recent studies show that there has been a marked extension of the cervical and dorsal spinal arthritis. The operation of sectioning the scalenus anterior succeeded in relieving the ulnar compression, but the operation was ill advised and should not have been performed. The spinal arthritis was not taken sufficiently

into consideration at the time of the operation. The cervical rib was not removed but it is doubtful that its removal would have changed the results.

Comment.—This case involves more than scalenus anterior syndrome; it was a combination of several pathologic entities and should not have been operated upon. It, however, illustrates another type of pathology and symptomatology different from the others, although the history of traumatism is associated with multiple others, symptomatology from which pathologic conditions she is still suffering. This case should be classed as a failure although the symptoms for which the operation was done were relieved.

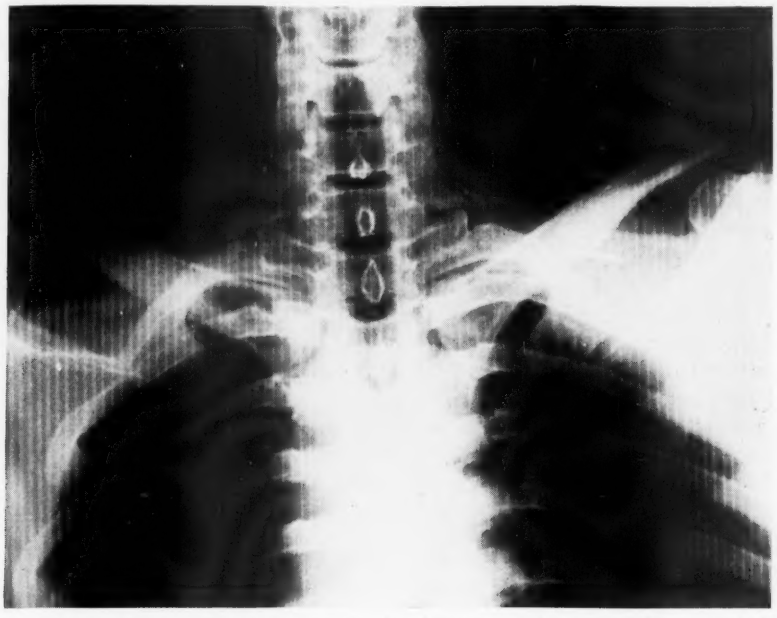


FIG. 4.—*Case 1:* Roentgenogram showing bilateral cervical ribs, neither of which articulates with the first rib. The one on the right is the larger, and extends almost to the rib.

CASES ILLUSTRATING MINOR DEGREES OF NEUROLOGIC AND VASCULAR COMPRESSION

Case 1.—A farmer, age 56, accustomed to drive a tractor, began to suffer from indefinite pains in the right arm and forearm. The pain was felt most in the medial side of the arm down to the hand and in the little and ring fingers, which were numb at times and stiff. He complained of not being able to use the hand and arm as he had formerly. There was an indefinite but constant pain in the shoulder and in the supraclavicular fossa. He continued to drive the tractor, but the pain became more severe and he sought relief from the discomfort. There were no changes in the skin reactions and no differences in temperature or pulse. When the head was held backwards and to the right, the pain was more acute, but there was no change in the pulse. Roentgenologic examination showed bilateral cervical ribs; the one on the right was the longer, but did not articulate with the first rib (Fig. 4). This was diagnosed as a mild degree of the lowest cervical trunk compression against the cervical rib, caused by dragging the shoulder downwards when driving a tractor. He was directed to drive the tractor

more carefully, to keep the shoulders held higher, and to sit erect when at work. He soon recovered from the pain. But, later, when he did not observe these precautions, the pain returned.

Case 2.—A woman, age 55, housewife, about five years ago began to suffer, at intervals, from a painful left shoulder; there were pain and stiffness in the arm, especially after much use of the limb. She slept on the right side because of pain when lying on the left. About four weeks ago, she began to have severe pain and numbness in the outer side of the arm and in the thumb, and second and third fingers; the fingers gradually became very numb and useless. Later the entire hand became numb and so stiff that she could not use it. She felt most comfortable with the arm held high over the chest and the shoulders backwards. When the pain became very severe, she had to sleep on her back. She now holds the arm pronated across the abdomen and complains of constant pain in it. Blood pressure in the right arm 220/130; in the left it could not be taken because of the pain and immediate swelling when the band was applied; however, the pulse is equal at the wrist and it is not affected in the left arm by turning the head to the left side. The whole outer side of the left arm is very tender, but there is no edema. There is a firm, resistant, nonpulsatile mass in the left supraclavicular fossa; the region of the scalenus anterior muscle is firm, enlarged as compared to the other side and very tender. Coordinated movements in both arms are equal, except for retardation in the left due to pain on any attempt to move it. The neurologic details will not be related here, but there were slight changes in the outer side of the left arm and fingers.

Roentgenologic examination shows that there is a marked cervical arthritis; that the transverse process of the seventh cervical vertebra is longer than normal; that there are no cervical ribs, but there is decalcification of the bones of the left shoulder joint. This is clearly a case of neuritis due to compression of the middle and upper nerve trunks without affecting the lowest trunk. The extreme pain when the cuff is used to determine the blood pressure is due to the tenderness of the muscles of the upper arm.

Case 3.—A male, age 21, farmer, began about ten years ago to have pain in the left shoulder and later in the arm following heavy farm work. The pain ranged down the outer side of the arm to the elbow; he has had spells of pain ever since, much worse when he uses the arm; he has not had swelling or edema of the arm or hand, but he has had tingling in all of the fingers except the thumb, especially after doing any hard labor which requires use of the left arm. The shoulder and arm have shrunken considerably, probably due to nonuse, as he has failed to use the arm for several years because of intense pain when he exercised it. The left shoulder is lower than the right. This is a case due to dropping of the shoulder. There are no changes in the pulse, pressure or volume in change of position in the arm. The roentgenogram showed a long, left cervical rib. He refused operation. He claims to have improved under postural and medical treatment.

Comment.—This case is interesting because of the absence of vascular symptoms; the symptoms are neurologic and have resulted in pain on use, loss of function of the arm and atrophy of the muscles. The pressure evidently does not affect the lowest trunk or there would probably be stimulation of the sympathetic and vasomotor nerves producing vascular changes.

REPORTS OF MILD NEUROLOGIC CASES

Postural and Age Defects

Case 1.—A female, age 54, who had never done any real labor, began to suffer from pain along the distribution of both ulnar nerves, which gradually increased in intensity until she was disabled. She became weak, listless, stoop-shouldered, *etc.* Roentgenograms showed bilateral ribs (Fig. 5). Tenotomy of both scalenus anterior

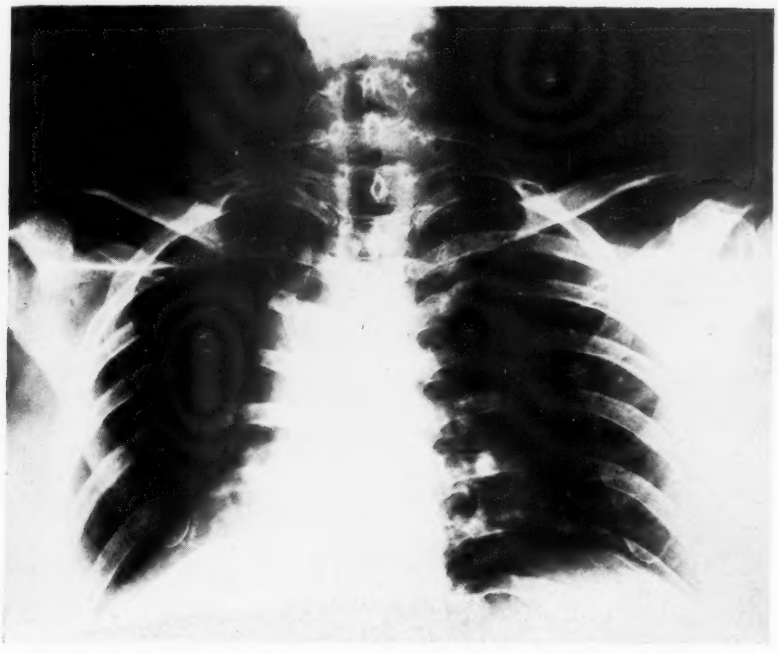


FIG. 5.—*Case 1:* Roentgenogram showing bilateral cervical ribs, well developed; the one on the right side articulates with the first rib, while that on the left side is almost in contact with the first rib.

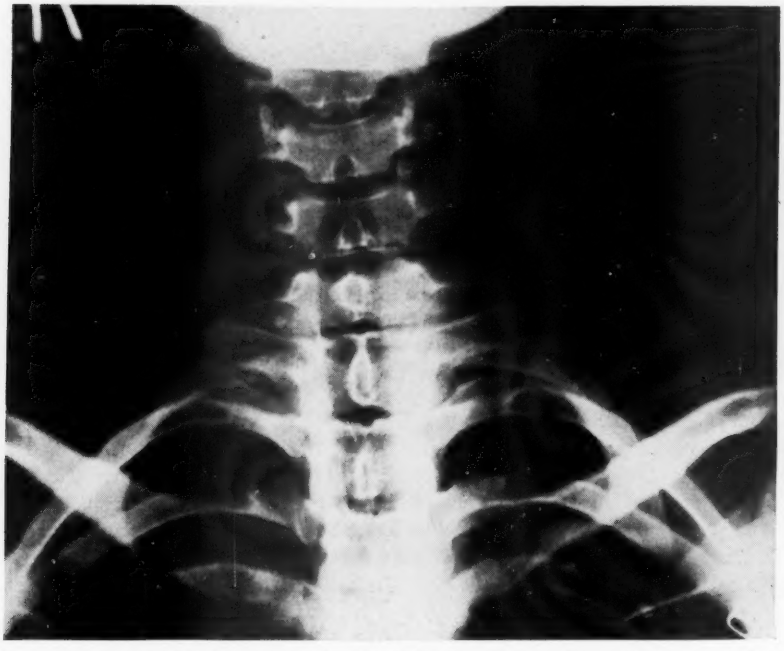


FIG. 6.—*Case 2:* Roentgenogram showing bilateral cervical ribs, well developed, but which do not articulate with the first rib.

muscles gave perfect relief. This case may be classified as both postural and age neurologic defects.

Case 2.—A female, age 26, greatly debilitated, and with much loss of weight, began to suffer, especially after physical effort, from pain in the ulnar nerve distribution and coldness of both arms and hands. Roentgenograms showed bilateral cervical ribs (Fig. 6). She was perfectly relieved by a change in postural habits and an increase in weight.

These two cases illustrate a type of scalenus syndrome occasionally seen in general practice.

MILD TRAUMATIC CASES

Case 1.—A strong, healthy male, age 18, was wrestling when he fell on the right shoulder and suffered acute pain in the shoulder and in the side of the neck. A few

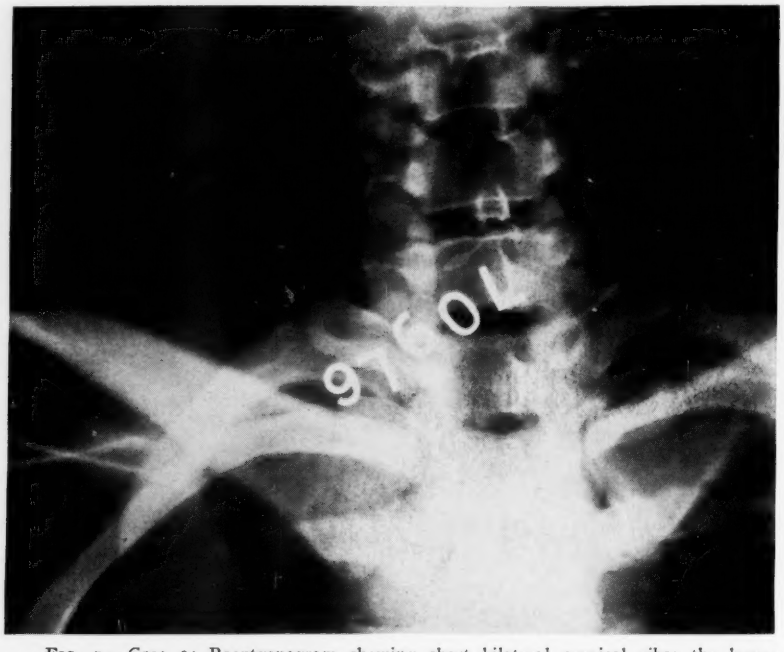


FIG. 7.—*Case 2:* Roentgenogram showing short bilateral cervical ribs; the larger one is on the right, but neither articulates with the first rib. The reproduction is rather indistinct but shows well on the original roentgenogram.

days later, he began to feel pain and numbness in the course of the ulnar nerve. Rest, hot applications, and mild faradic current were employed. In a few weeks, he was well.

Case 2.—A truck driver, age 21, fell off a truck and struck the left shoulder on the pavement. Since then, he has felt numbness of the arm, tingling of the little and ring fingers; he cannot abduct or flex the forearm; the hand hangs limp and is cold. Roentgenograms disclosed short, bilateral cervical ribs (Fig. 7). After the settlement of a suit, he could abduct the arm but all of the other symptoms remain.

Case 3.—A female, age 28, housewife, complained of bilateral shoulder pain, numbness in the little and ring fingers following exercise or lifting, *etc.* Roentgenograms showed small, bilateral cervical ribs. She was relieved by rest and corrective posture.

MILD CASES DUE TO ACUTE INFECTION

Case 1.—A healthy male, age 53, had a severe attack of influenza during which he suffered severe throat inflammation. A few weeks after recovery, he began to suffer

from a most distressing ulnar neuritis associated with coldness and numbness of the fourth and fifth fingers. This lasted for several months, followed by recovery. Other cases have been observed.

Classification of the Types of Cervicobrachial Syndrome.—The symptoms under the general heading cervicobrachial syndrome may be, for purposes of study, classified into three well-defined categories, *viz.*:

First, Those cases which exhibit neurologic symptoms as their major manifestation.

Second, Those cases which exhibit vascular symptoms as their major manifestation.

Third, Those cases which exhibit a combination of both neurologic and vascular symptoms.

These three classifications are definitely separated by diagnostic criteria which are easily recognized and classified. They arise from, and are an expression of, the major pathology of the disease. The causes of these conditions are similar, but the expression of the pathologic processes is different. That is, compression of either the neurologic structures or the vascular trunks produces symptoms peculiar to their functions. It is the pathologic reaction of these two different anatomic tissues either to intermittent or to long continued pressure—in the nerve tissues it is numbness, pain, paralysis and loss of function; in the vascular structures it is moderate pain, edema, swelling, obstruction of the blood flow finally ending in clotting in the vessels and, if serious enough, death of the tissues supplied by these vessels.

This theory is very simple and clarifies the diagnostic problems. The location of the pathology is confined to a small area in the neck but one which is full of nerves and blood vessels, surrounded by muscles and osseous structures which have undergone great and vital changes in the course of evolution and embryology. Many, if not all, of the diseases in this small region are the result of developmental defects. At this juncture, a discussion of the embryology and the anatomy is necessary to an understanding of the structures involved.

Embryology of the Cervicobrachial Region.—There are certain regions of the spine which are called "unstable";[40] these regions lie at the junction of one section of the spine with another, *viz.*: the cervicodorsal, dorsolumbar and the lumbosacral junctions. At an early stage of the development of the vertebrae all are of the same generalized type; later, the vertebrae of each body segment assume their peculiar forms but it is not unusual for one vertebra to assume some or all of the characteristics of the one above it or below it. These variations are often of clinical importance. The cervical ribs arise embryologically from centers of ossification in the anterior root of the transverse processes of the seventh, sometimes the sixth, cervical vertebra; these appear about the sixth month of fetal life. In all of the cervical ribs, except the seventh, sometimes in the sixth, the centers of ossification disappear; from this center, a rib may develop. In the higher vertebrates, such as man, there should be no cervical ribs. When the limb buds appear, they crowd out

the rib centers; also, the development of the nerves supplying the limbs encroaches upon the rib centers and aids the limb buds, preventing their development.

At an early stage, the nerves and limb buds grow out at right angles to the vertebrae, but with the growth and increase in size, they assume a downward position as the spine lengthens upward, which increases the disproportion between the vertebrae and the nerve roots. As this descent of the nerves takes place, a conflict arises between the rib centers and the growing nerve trunks. This theory[43] may explain the disappearance of the cervical ribs. This region is subject to other changes in the arrangement of the sympathetic and vasomotor nerves as they are reflected downwards and are incorporated into the lower nerve trunks where they cause severe pain and other changes in function when any obstruction is pressing on the nerve trunks.

It is interesting to note that the first lumbar vertebra occasionally develops a rib comparable with the cervical ribs; the embryology may explain some of the painful lumbar spinal cases.

Anatomy of the Neck.—Briefly stated,[42] the first rib is the shortest in the body, except the twelfth. It lies in the boundary between the neck and thorax, largely under cover of the clavicle; its posterior end is above the clavicle, and its anterior end is immediately below the clavicle. The groove for the artery is about the middle of the body; the groove for the vein is nearer the anterior end. Between the grooves for the artery and the vein is a tubercle, the scalene tubercle, to which is attached the anterior scalene muscle and to the rough area on the rib; the surface behind the groove for the artery gives insertion to the middle scalene muscle. The greater part of the anterior ramus of the first thoracic nerve, on its way to join the brachial plexus, runs upwards and laterally in front of the neck and then lies in the posterior part of the groove for the artery, between the artery and the scalenus medius. In some cases, there is a special groove for the lodgment of the first thoracic nerve, or the lowest trunk of the brachial plexus, immediately behind the groove for the artery. The first rib articulates with only one facet to the first thoracic vertebra.

The scalenus anterior arises from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebrae and runs down laterally to attach to the scalene tubercle of the first rib in front of the subclavian artery; the scalenus medius arises from the posterior tubercles of the transverse processes of the second to the sixth cervical vertebrae. Both muscles aid in respiration, in fixing the neck, *etc.* They are supplied by branches which arise directly from the anterior rami of the lowest four or five cervical nerves. Callender[41] says that branches from the seventh and eighth primary divisions supply the longus colli and the scaleni. When the cervical rib is more than 5 cm. it displaces the subclavian artery and the brachial plexus upwards.

If the chest is lengthened by a cervical rib, there is a higher arch and a sharper curve in the subclavian artery. Unless the rib is well developed, it is

too short to support the artery, and may be crossed only by the lower trunk of the brachial plexus. The most frequent results are the nerve phenomena referred to the arm and hand due to pressure on the lower trunk which is composed of the eighth cervical and first thoracic nerves which supply the inner side of the hand and arm.

THEORIES OF THE ETIOLOGY OF THE CERVICOBRACHIAL SYNDROME

(1) Compression of the nerve trunks as they pass between the scalenus anterior and the scalenus medius.

(2) Injury to the nerve trunks and the subclavian artery as they cross the normal rib or a cervical rib; or are obstructed between clavicle and normal or cervical rib.

(3) Injuries to the sympathetic and the vasomotor nerves supplying the subclavian artery by the scalenus anterior, or cervical rib, producing vascular damage.

(4) Traumatism, direct or indirect, of the scalenus anterior muscle resulting in fibrosis and contraction, which compress the nerve trunks and the subclavian artery.

(5) Embryologic defects which alter the course of the nerve trunks in relation to the scalene muscles and normal or cervical ribs.

(6) Postural or functional defects, such as dropping of the shoulder girdle, due to ill health, faulty postural habits, occupational and vocational habits, advanced age, *etc.*

(7) Narrowing of the upper thoracic cap as a result of adjacent infections or anatomic defects.

(8) Acute infections producing myositis.

(9) Intermittent traumatism to the subclavian artery by cervical rib or normal rib, due to normal movements of the shoulder joint.

Discussion.—The recent literature has numerous reports of cases presenting the typical scalenus syndrome without either a cervical rib or a compressing first rib; the cause of the symptoms seems to be limited to contraction of the scalenus anterior muscle. Naffziger[39] reports 18 cases presenting symptoms of scalenus syndrome, 12 of which had no cervical ribs and six had very small ribs present but they were not observed at operation. Tenotomy of the scalenus anterior muscle gave relief of all of them. The relief in a few was delayed for several months. In this report, no mention was made of the condition of the cervical spine as to the presence of arthritis or other conditions which have been reported as possible etiologic factors. MacDermott[20] remarks that a normal first rib may produce all of the symptoms of a cervical rib; Flothow[21] reports two cases without cervical ribs, one with a "nubbin" of a first rib; Edington[13] likewise reports one case without cervical rib or any other protuberance which might cause compression; he cites cases from the literature (Murphy, Morley, Wood, Jones, Stopford,[48] Wingate Todd and Telford and Stopford). Haven,[23] also, cites two cases from the Mason Clinic which presented the symptoms of scalenus syndrome with normal first ribs

and no cervical ribs. Many others could be quoted from the recent literature.

These observations would suggest that there is something besides bony malformations and anatomic defects which may be the underlying cause of the symptoms. Operative success has demonstrated the relief which comes from section of the scalenus anterior muscle, but that does not postulate a cause of the pathologic condition of the muscle involved; it merely states the results of a pathologic condition without defining or explaining its etiology. What the etiology of scalenus anterior spasm is may be surmised from a variety of causes which have been suggested.

If scalenus spasm has been associated with cervical rib, normal rib, fibrous tissue formation in the surrounding tissues, with or without injury to the shoulder, following acute illness, *etc.*, there must be some definite, basic irritation acting upon the muscle which, under a multitude of influences, becomes spastic, constantly or intermittently, and produces neuritis or vascular occlusion in some degree which may be explained by presupposing damage to the nerve supply. In the pure cervical rib cases, constant and prolonged pressure upon either the nerve trunks or their sympathetic and vasomotor fibers or upon the vessel walls and, also, their nerve fibers, seems to produce all of the symptoms of scalenus syndrome. Todd[45] was among the first to advocate the theory of nervous disturbances due to embryologic defects as the cause of the arterial symptoms as well as the nervous origin of the neurologic reactions. The nerve supply[41] of the scalenus anterior comes from the two lowest nerve trunks which are the ones most compressed; this may explain the tension of the scalenus muscle. Telford and Stopford[10] support the same opinion as to the neurologic origin of the vascular symptoms. In 1914, Halsted showed experimentally that the aneurysmal dilation of an artery is distal to the constricting agent; this explains why aneurysm of the subclavian artery is distal to the cervical or normal first rib.

RÉSUMÉ

This paper records a series of case reports with a partial review of the literature. Twenty cases are reported which have been examined by the writer. Traumatism is emphasized as an etiologic factor in approximately 80 per cent of them. Twelve cases were operated upon with satisfactory results except one case which was unsuitable for tenotomy of the anterior scalene muscle.

A review of the current literature convinces one that the nomenclature should be simplified upon an anatomic or pathologic basis so that it will describe and define the symptomatology more accurately. The review further shows that there are many different pathologic conditions in the small area of the neck which are due to only a few anatomic structures which have become abnormal in their functions. These are the scalene muscles, cervical ribs, normal first thoracic ribs, the clavicle, the cervical nerve trunks, the subclavian artery, and the sympathetic and vasomotor nerves.

The symptoms of disease of the structures are either those of neuritis or

vascular pathology. The area of disease is limited to the hands, arms, shoulders, side of the neck and side of the head; they are either vascular, neurologic or both combined. In order to simplify the nomenclature and to express a more correct symptomatology, the term "cervicobrachial syndrome" is suggested.

BIBLIOGRAPHY

[1] Patterson, Russel H.: Surgery for Cervical Ribs. ANNALS OF SURGERY, **102,** No. 6, 972–979, December, 1935.

[2] Riches, E. W.: The Anatomy of Cervical Rib: With a Report of a Case. Brit. Jour. Surg., **16,** 235–238, October, 1928.

[3] Pfeiffer, George E.: Cervical Rib with Excision. U. S. Vet. Med. Bull., **5,** 898–901, November, 1929.

[4] Cervical Rib with Vascular Complications (With Special Plate). Brit. Med. Jour., **1,** 782-783, May 6, 1933.

[5] Kasman, Louis P., and Bernstein, William: Cervical Ribs. Am. Jour. Surg., **30,** 372–375, November, 1935.

[6] Rubin, Lionel C., and Cipollaro, Anthony C.: Onxchodystrophy Caused by Cervical Rib. Arch. Derm. and Syph., **39,** 430–433, March, 1939.

[7] Wilbour, L. S.: Cervical Rib. Jour. Okla. S. Med. Assn., **23,** 106-108, April, 1930.

[8] Cervical Rib and Scalenus Anticus Syndrome. J.A.M.A., **109,** 877–878, September 11, 1937.

[9] Lindskog, G. E., and Howes, E. L.: Cervical Rib Associated with Aneurysm of the Subclavian Artery. Arch. Surg., **34,** 310–319, February, 1937.

[10] Telford, E. D., and Stopford, John S. B.: The Vascular Complications of Cervical Rib. Brit. Jour. Surg., **18,** 557–564, April 1931.

[11] Oljenick, Ignaz: Bilateral Cervical Rib; Clinical and Experimental Observations on a Case. Arch. Surg., **18,** 1984–2007, April, 1929.

[12] Davis, David Bennett, and King, J. Cash: Cervical Rib in Early Life. Amer. Jour. Dis. Child., **56,** 744–755, October, 1938.

[13] Edington, G. H.: Cervical Ribs. Glasgow Med. Jour., **118,** 289–313, November, 1932.

[14] Robinson, S., Stone, C. S., Jr., and Elliot, A. H.: Cervical Ribs. Western Jour. Surg., Obstet. and Gynec., **43,** No. 6, 295–304, June, 1935.

[15] Arostegui, Gonzalo E.: Supernumerary Cervical Rib. Jour. Mt. Sinai Hosp., **4,** 189–197, November–December, 1937.

[16] Adson, Alfred W.: Cervical Rib. Atlantic Med. Jour., **31,** 222–232, January, 1928.

[17] Collins, Clifford, U.: Cervical Ribs. Am. Jour. Surg., **14,** No. 2, 449–451, November, 1931.

[18] Von Klimko, V.: Beitr. z. klin. Chir., Bruns', 168 Bd., Heft 1, July 13, 1938.

[19] Baumgartner, A., Clerc, A., and Macrez, C.: Les Côtes Cervicales. Presse Méd., 46 Année, **91,** November 12, 1938.

[20] MacDermott, E. N.: Tenotomy of the Scalenus Anticus; A Substitute for Resection of a Cervical Rib, with Report of a Case. Irish Jour. Med. Sci., Sixth Series, **98,** 81–88, February, 1934.

[21] Flothow, Paul G.: Cervical Rib and the Anterior Scalenus Syndrome. Western Jour. Surg., Obstet. and Gynec., **44,** No. 10, 571–573, October, 1936.

[22] Adson, A. W., and Allen, E. V.: Proc. Staff Meet. Mayo Clinic, **13,** No. 40, 637–640, October 5, 1938; Vascular Clinics. Vi. Thrombosis of Arteries of the Right Upper Extremity Resulting from Anomalous First Rib.

[23] Haven, Hale: Neurocirculatory Scalenus Anticus Syndrome in the Presence of Developmental Defects of the First Rib. Yale Jour. Biol. and Med., **11,** No. 5, 443–445, May, 1939.

[24] Adson, A. W.: Surgical Treatment of Cervical Ribs. Tex. S. Jour. Med., **28,** 739, March, 1933.

[25] Adson, A. W., and Coffey, J. R.: Cervical Rib; A Method of Anterior Approach for Relief of Symptoms by Division of the Scalenus Anticus. ANNALS OF SURGERY, **85,** 839, June, 1927.

[26] Boorstein, S. W.: Cervical Rib, with a Report of Six Cases; One Operative. Jour. Bone and Joint Surg., **4,** No. 4, 687–704, 1922.

[27] Carroll, W. C.: Cervical Ribs and Abnormal First Thoracic Ribs. Minnesota Med., **15,** 828, December, 1932.

[28] Collins, C. U.: Cervical Ribs. Am. Jour. Surg., **14,** 449, November, 1931.

[29] Craig, W. McK., and Nepper, P. A.: Cervical Rib and the Scalenus Anticus Syndrome. ANNALS OF SURGERY, **105,** 556, April, 1937.

[30] Gage, M.: Scalenus Anticus Syndrome. Surgery, **5,** 599, April, 1939.

[31] Honeij, J. A.: Cervical Ribs; With Presentation of Cases and a Bibliography. Surg., Gynec. and Obstet., **30,** 481, 1920.

[32] Kleinberg, S., and Levine, M. A.: Headache as a Symptom of Cervical Rib. ANNALS OF SURGERY, **105,** 299, February, 1937.

[33] McKenna, C. H.: A Report on Two Cases of Cervical Rib and An Operative Measure to Prevent Recurrence of Symptoms. Surg., Gynec. and Obstet., **16,** 322, 1913.

[34] Morris, C. H.: Syringomelia Associated with Cervical Ribs, J.A.M.A., **78,** 109, 1922.

[35] Ochsner, A., Gage, M., and DeBakey, M.: Scalenus Anticus (Naffziger) Syndrome. Am. Jour. Surg., **28,** 669, June, 1935.

[36] Plummer, S. C.: Two Cases of Operative Removal of Cervical Ribs. Surg., Gynec. and Obstet., **10,** 321, 1910.

[37] Rao, N. M., and Rao, L. M.: Two Cases of Bilateral Cervical Ribs. Indian Med. Gaz., **69,** 689, December, 1934.

[38] Reid, W. D.: Pressure on the Brachial Plexus Causing Simulation of Coronary Disease. J.A.M.A., **110,** 1724, May 21, 1938.

[39] Naffziger, H. C., and Grant, W. T.: Neuritis of the Brachial Plexus Mechanical in Origin; The Scalenus Syndrome. Surg., Gynec. and Obstet., **67,** 722, 1938.

[40] Keith, Sir Arthur: Human Embryology and Morphology. 5th Ed., Wm. Wood & Co., Baltimore, 1933.

[41] Callender, C. Latimer: Surgical Anatomy. W. B. Saunders Co., Philadelphia, 1933.

[42] Cunningham, D. J.: A Text-Book of Anatomy. 5th Ed., Wm. Wood & Co., New York, 1923.

[43] Jones, F. W.: The Anatomy of Cervical Ribs., Proc. Roy. Soc. Med., **6,** Part 1 (Clin. Sect.), 95, 1912–1913.

[44] Murphy, J. B.: The Clinical Significance of Cervical Ribs. Surg., Gynec. and Obstet., **3,** 514, 1906.

[45] Todd, T. W.: The Descent of the Shoulder after Birth. Its Significance in the Production of Pressure-Symptoms on the Lower Brachial Trunk. Anat. Anzeiger, **41,** 385, 1912.

[46] Hill, R. M.: Vascular Anomalies of the Upper Limbs Associated with Cervical Ribs. Report of a Case and Review of the Literature. Brit. Jour. Surg., **27,** 105, 1939.

[47] Eden, Kenneth C.: The Vascular Complications of Cervical Ribs and First Thoracic Rib Abnormalities. Brit. Jour. Surg., **27,** 105, 1939.

[48] Stopford, John S. B.: Gunshot Injuries of the Cervical Nerve Roots. Lancet, **1,** 336–338, March 1, 1919.

DISCUSSION.—DR. MIMS GAGE (New Orleans, La.): I have enjoyed the presentation of both Doctors Donald and Aynesworth, and especially that part which dealt with etiology and diagnosis. In the Surgical Clinic at Tulane, we have been interested in the study of the scalenus anticus syndrome for some

time. In 1934, we presented the two prevailing theories: (1) Todd's failure of descent of the shoulder girdle; and (2) Jones' low origin of the brachial plexus. To these two we added "spasm of the scalenus muscle." The latter we believed to be responsible for the persistence of this most interesting clinical entity. I was able to confirm that spasm of the muscle was responsible for the persistence of the symptoms by blocking the scalenus anticus muscle with 1 per cent novocain. This resulted in relief of the symptoms for varying periods of time (longest, ten hours). In two cases of cervical rib and three cases of scalenus anticus syndrome without cervical rib, there was temporary relief of symptoms, which is suggestive that spasm is responsible for the persistence of symptoms. Therefore, I have been quite interested in trying to discover the etiologic factor or factors responsible for the spasm of the scalenus anticus.

In conjunction with Doctors Reed and Weed of the Department of Gross Anatomy, a study is now being made of the scalenus anticus muscle, its origin and variations in attachment. To our surprise, we have found that there exists a scalenus anticus major and minor in a number of the subjects, the brachial plexus and subclavian artery passing between the scalenus major and minor in all cases in which this condition has been found. To date, 27 cadavers have been dissected and we have found eight instances of scalenus anticus major and minor. This anomaly was found bilaterally five times, and was unilateral in three, two on the left and one on the right side. In two instances the brachial plexus was found to pass through the fibers of the scalenus anticus muscle. These findings may have a direct bearing upon the etiology of the scalenus anticus syndrome. It will be of interest in all future operations performed for the relief of this interesting clinical entity to thoroughly investigate the brachial plexus and scalenus anticus muscle and report all anomalies found in this anatomic area. We should determine the presence or absence of the scalenus anticus major and minor as well as the passage of the brachial plexus through the above muscle.

DR. LUCIAN H. LANDRY (New Orleans, La.): It would seem that there might be some misleading elements in the diagnosis of cervical rib. I am reminded of this by four cases which were sent to the service of Doctor Matas with a diagnosis of subclavian aneurysm, simply because the subclavian artery was displaced or elevated by a cervical rib and produced pulsation in the supraclavicular space.

We did have one case of cervical rib in a woman who fell down a stairway on shipboard, and the trauma, plus the preexisting cervical rib, was instrumental in producing a subclavian aneurysm.

DR. ALTON OCHSNER (New Orleans, La.): In addition to the diagnostic test which Doctor Gage has described, I should like to call attention to a procedure which we feel is of value in cases of scalenus anticus syndrome, and which can be simply performed. If the scalenus anticus muscle is put under tension, the symptoms are likely to be aggravated and there is a likelihood of compression of the subclavian artery which can be detected by a diminution in pulse by such a maneuver. As the scalenus anticus takes origin from the transverse processes of the upper cervical vertebrae, if the patient will extend his head and turn the face toward the affected side, thus throwing the attachment of the scalenus anticus backward and rotating the vertebrae to increase the tension of the scalenus anticus, one can make observations concerning the pulse. This can be detected either by palpating the pulse or, graphically, by means of oscillometrograms taken before and after turning of the head.

Because of a recurrence which we had in one case following simple division of the muscle, we believe that myotomy is not sufficient in cases of scalenus anticus syndrome but that an extirpation of a portion of the muscle should be performed in order to prevent bridging of the gap by scar tissue and recurrence of symptoms.

As Doctor Gage stated, we have found, invariably, definite hypertrophy of the muscle, which is probably the result of its continued stimulation. We believe that a vicious circle is set up; as a result of constriction of the muscle there is an irritation of the brachial plexus which in turn causes contraction of the muscle and aggravates the condition. It was interesting to me that in Doctor Donald's patients the most frequent occurrence was on the left side. In our experience the right side is usually involved in right-handed people. Even with cervical ribs which are more likely to be on the left than on the right the symptoms are more likely to be on the right side. It is more frequent in women and is likely to be aggravated by such motions as sweeping.

Dr. K. H. Aynesworth (Waco, Tex., in closing): There is not much to add except to mention that there was a history of traumatism in all cases except four. Frequently the trauma is from driving a tractor. If you have seen these in action, you know how they go over rough plowed ground and how the shoulders are subjected to possible injury. Some of my patients have had to stop driving tractors to get relief. I devised a figure-of-eight bandage, and when they wore this they could drive, but if they left it off the pain returned. I am not able to distinguish between trauma and other causes, but if you relieve the trauma you relieve the pain. It occurs to me that trauma plays a definite rôle in the causation of the scalene syndrome. The patient loses weight and you have this dropping of the shoulders. I am not yet ready to accept the theory that the scalenus disease is the sole cause of this syndrome. I look upon the constricted muscle as a result of injury to the nerves, and knowing the pathway of the nerve supply makes this theory most logical. We know that the cervical spine and the sacrococcygeal spine have lost their ribs and have a highly developed nerve supply which is greatly interfered with in subsequent development of these structures. I strongly suspect that many cases of lumbago may be explained on the same embryologic or neurologic basis.

PARTIAL GASTRECTOMY*

A CONSIDERATION OF CERTAIN TECHNICAL PROBLEMS

ROY D. MCCLURE, M.D., AND LAWRENCE S. FALLIS, M.D.
DETROIT, MICH.

FROM THE DEPARTMENT OF SURGERY, HENRY FORD HOSPITAL, DETROIT, MICH.

PARTIAL GASTRECTOMY is the operation of choice for intractable duodenal and gastric ulcers. This opinion is shared by all surgeons who have had an extensive personal experience with the procedure, and it is encouraging to find that the greatest number of enthusiasts are included among those who have had the most experience. The reason for this trend of thought is twofold, for the present mortality of 5 per cent following partial gastrectomy in competent hands is not greater than that following the more limited operations, and the end-results are infinitely better, because extensive removal of diseased gastric mucosa leads to a lessened incidence of gastrojejunal ulceration. The operation of partial gastrectomy is usually a straightforward procedure, the performance of which presents no problem to the well-trained surgeon possessed of an intimate knowledge of the anatomy of the upper abdomen. However, an operation of this magnitude is not infrequently fraught with technical difficulties which may tax the skill of the most ingenious operator. It is in circumstances like these that experience counts. In our own hands a mortality rate of 10 per cent for a 15-year period has been reduced to 5 per cent during the past five years, and in the last 53 consecutive partial gastrectomies for ulcer, there has been but one death. We attribute this lowered mortality in part, at least, to an increasing familiarity with the condition which has resulted in the adoption of what we believe to be improvements in our technic.

The essential steps of the operation are so well standardized that detailed reference to them is unnecessary. We will, therefore, confine the discussion to those technical points which we consider to be of major importance.

Preparation of the Patient for Operation.—Patients about to be submitted to partial gastrectomy must be put in the best possible physical condition. The hemoglobin should be brought to at least 70 per cent, by blood transfusions if necessary. Dental prophylaxis is an essential part of the preparation because of the necessary postoperative period of fasting. On no account should operation be undertaken in the presence of respiratory tract irritation, and surgical procedure should be postponed for at least six weeks following even mild upper respiratory infections, since pulmonary complications following gastrectomy are always serious. The stomach is washed repeatedly with bicarbonate of soda solution during the two days previous to operation. Just

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

before the patient is sent to the operating room, a final lavage is given with half strength hexyl-chloro-meta-cresol, an antiseptic solution with a high phenol coefficient and low toxicity for tissue cells, developed by Dr. Frank Hartman,[1] of our staff. About 200 cc. of this solution is left in the stomach by clamping off the indwelling tube until the operation begins, when the clamp is released and the antiseptic is withdrawn with an aspirating syringe. The ordinary cleansing enema is not sufficient to clear the colon, for most of these patients have been on a low residue diet, and many of them have recently had barium. Therefore, repeated oil retention enemata and colonic lavages are necessary to cleanse the colon.

Anesthesia.—Mobilization, the keynote of successful gastro-intestinal surgery, can be accomplished best only in the presence of perfect relaxation. We have found that spinal anesthesia, with nupercain administered by the Jones[2] method, best fulfills this requirement. Adequate anesthesia with this agent, lasting from two to three hours, is the rule rather than the exception. This, and freedom from systemic depression, makes nupercain stand in marked contrast to the anesthesia of uncertain height and duration so commonly obtained with other high spinal anesthetics. Seconal, gr. iii, given before the patients leave for the operating room plus a hypodermic injection of morphine sulphate, gr. ¼, given after the nupercain, insures a peaceful anesthetic period for even the most nervous patient. Blood pressure is maintained at normal levels by hypodermic injection of ephedrine, gr. 1½, and by the routine intravenous administration of 600 cc. of 10 per cent glucose followed by 600 cc. of citrated blood, for we are convinced of the necessity of avoiding anoxia[3] produced by sudden and pronounced fall in blood pressure. The good appearance of the patient at the conclusion of the operative procedure, and the excellent general condition on the following day, will convince the most skeptical of the advantage of spinal over general anesthesia. Atelectasis is just as common with the spinal anesthesia, but serious pulmonary complications are decidedly fewer.

Incision.—We have continued to use the midline incision going directly through the linea alba. The skin incision either skirts to the left of the umbilicus or excises this structure completely and usually extends two inches below it to provide ample room. This method of entering the abdominal cavity has the advantages of speed, bloodlessness, and of not entering any of the fascial spaces, so that if wound infection does occur, there is minimal loss of important structures. It is important in suturing this incision to use interrupted, nonabsorbable sutures and to clear away the fatty structure of the round ligament of the liver so that the fascial edges of the linea alba can be approximated without inclusion of fat tags. In our experience, incisional hernia has not been any greater than with rectus reflecting or rectus splitting incisions.

Mobilization of the Duodenum.—Mobilization of the duodenum is begun by first identifying the common duct by freeing the pylorus, after sectioning the leash of blood vessels constituting the right gastric artery. We have found

that mobilization of the pylorus and duodenum is facilitated by encircling the prepyloric area of the stomach with a ring clamp we have devised (Figs. 1 and 2), which acts as a handle and enables the surgeon to apply tension

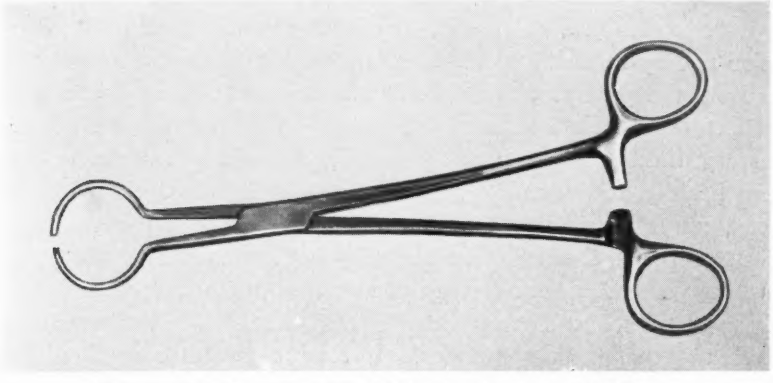


FIG. 1.—The ring clamp for applying traction to the duodenum.

to the duodenum in the desired direction, thereby delineating the line of cleavage between the duodenum and head of the pancreas. Sharp scalpel and gauze

FIG. 2.—Duodenum just before sectioning. The McClure modification of the Furniss clamp is shown in place, with the ring clamp just proximal to the pylorus.

finger dissection will accomplish separation of the suprapapillary portion of the duodenum and the pancreas in gastric, pyloric, and nonpenetrating duodenal ulcers. However, in practice, the surgeon seldom encounters any but

penetrating ulcers, for it is just this type that resists palliative measures and eventually comes to operation. The chief danger in dealing with penetrating ulcers is of inadvertently injuring the common bile duct because of distortion of tissue from the accompanying inflammatory reaction. The best protection of the duct is obtained, of course, by identifying it before commencing the dissection and by referring to it constantly during the separation of the duodenum from the pancreas. Penetrating ulcers with small bases are usually opened into during the course of the freeing of the duodenum, and all that is necessary, then, is to continue the mobilization distal to the ulcer bed until sufficient healthy duodenum is freed to permit satisfactory closure. A minimum of 1 cm. is required. When dealing with the larger penetrating ulcers, it is best to open the anterior wall of the duodenum close to the pylorus in order to inspect the interior of the duodenum and to make certain that sufficient healthy tissue, to effect a closure, lies between the inferior margin of the ulcer and the papilla of Vater. If closure is still considered feasible, the duodenum is dissected away from the pancreas, leaving the ulcer base undisturbed. But if closure of the duodenum below the ulcer is likely to result in encroachment on the papilla of Vater, it is advisable to section the duodenum proximal to or even through the ulcer base, for experience has shown that these ulcers will cicatrize after diversion of the stomach contents. The operation then proceeds just as if the ulcer had been removed. In certain instances where the amount of inflammatory reaction surrounding the penetrating ulcer is so great that the pylorus, proximal duodenum, and pancreas appear to form a conglomerate mass, we have found that it is good practice to follow the advice of Finsterer and section the prepyloric area of the stomach[4] instead of attempting to mobilize the duodenum. The distal cut end of the stomach is closed by infolding after excising the mucosa.

Method of Sectioning the Duodenum.—We prefer the Furniss clamp method, because with a minimal sacrifice of tissue, bleeding is controlled, spillage of duodenal contents is avoided, and the tied catgut suture provides an excellent medium of control for the duodenal stump. There are, however, certain instances where, in spite of maximum mobilization, the duodenum lies at such a depth in the wound that application of the standard Furniss clamp is impossible or is accomplished only with great difficulty. One of us (R. D. McC[5]) has devised a modification of the Furniss clamp with smaller blades and a detachable handle, thereby retaining all the advantages of the shirring principle and permitting its application where access is limited (Fig. 3). The pylorus and mobilized duodenum are steadied with the ring clamp. The modified Furniss clamp is applied to the duodenum at the proposed site of section, closed by means of its detachable handle, and then locked. A *straight intestinal needle* swedged in No. 00 chromic catgut *is then inserted* through the eye in the blades, thereby fixing the shirred margin of duodenum in the clamp. A Kocher or a small Payr clamp is applied proximal and close to the Furniss clamp, and the duodenum is sectioned (Fig. 4). Both cut surfaces are swabbed with antiseptic solution, and the

proximal end of the duodenum is enveloped in a gauze pad and turned over to the left.

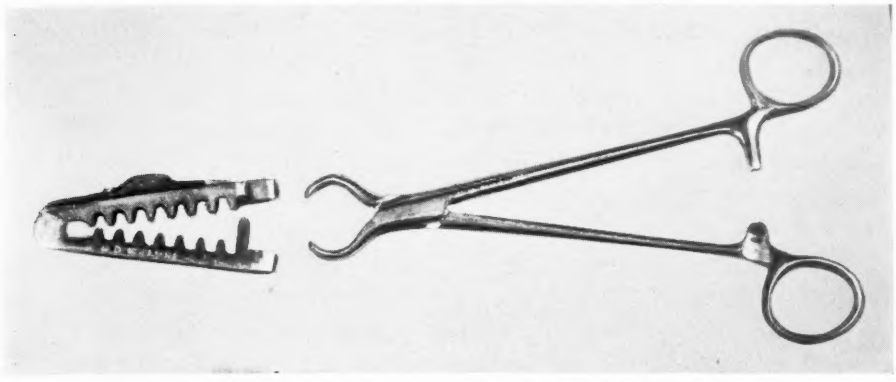


FIG. 3.—The modified Furniss clamp with its detachable handle.

Closure of the Duodenal Stump.—Closure of the duodenal stump is a most important step in the operation of partial gastrectomy, for duodenal leakage is a serious complication, and accounts for the majority of fatal issues.

FIG. 4.—Duodenum after sectioning. The needle is being passed through the stump of the duodenum preparatory to removing the duodenal clamp.

The handle of the modified Furniss clamp is detached, and the clamp is unlocked and removed. The needle previously inserted through the eye in the blade is seized at its tip and drawn through the shirred duodenal edge,

bringing with it the chromic catgut suture which is now tied, thus effectually closing the duodenum and controlling hemorrhage. The ends of the catgut are left long and used as a handle to control the duodenum until a purse-string suture of fine silk is put in the duodenal wall 2 cm. from the line of section. The cut end is inverted, and the suture tightened but not tied until three or four Lembert sutures of fine silk are inserted and tied (Fig. 5). We make quite a point of delaying the tying of the purse-string suture until Lembert sutures are put in and tied, for then, if the purse-string suture breaks, as not uncommonly occurs with fine silk, eversion of the cut edge

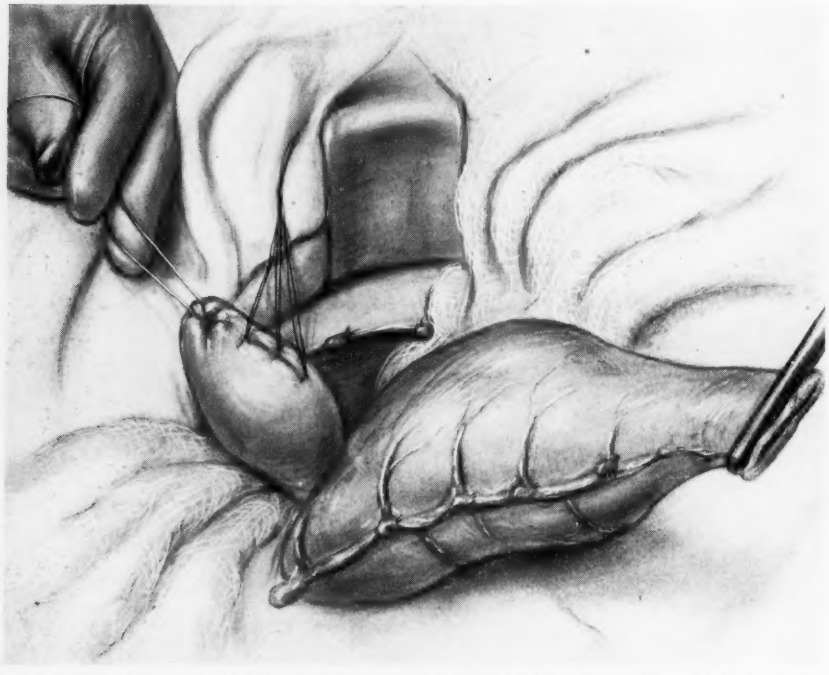


FIG. 5.—The closing of the duodenal stump. The purse-string is being held while the interrupted silk sutures are placed.

cannot occur. The first row of Lembert sutures is reinforced at intervals and the suture line further secured with omental tags or adjacent pancreatic tissue.

Preservation of the Middle Colic Artery.—Injury to the middle colic artery is an easily avoidable complication of partial gastric resection. It is always endangered when the gastrocolic omentum is sectioned, when the right gastro-epiploic artery is ligated and when the posterior gastric wall is adherent to the anterior leaf of the mesocolon, as occurs in the posterior wall of perforating gastric ulcers. Protection of the middle colic artery begins with identification of the vessel before any operative step is undertaken, continues by constant reference to its position and ends only when the opening in the transverse mesocolon is sutured to the gastric wall as the concluding step in the operation. A good practical rule to follow is not to clamp any large artery until one is certain that the vessel in question is not the middle

colic artery. In sectioning the gastrocolic omentum, the lesser peritoneal cavity should be entered first and the gastric colic omentum separated from the transverse mesocolon. It is well to bear in mind that the gastrocolic omentum has no vascular connection with the transverse colon, so that any structure with blood vessels entering the colon must be mesocolon and, therefore, should not be cut.

Ligation of the Left Gastric Artery.—Mobilization of the stomach is complete only when the left gastric artery is sectioned. This vessel arises from the celiac axis and runs forward and upward toward the posterior wall of

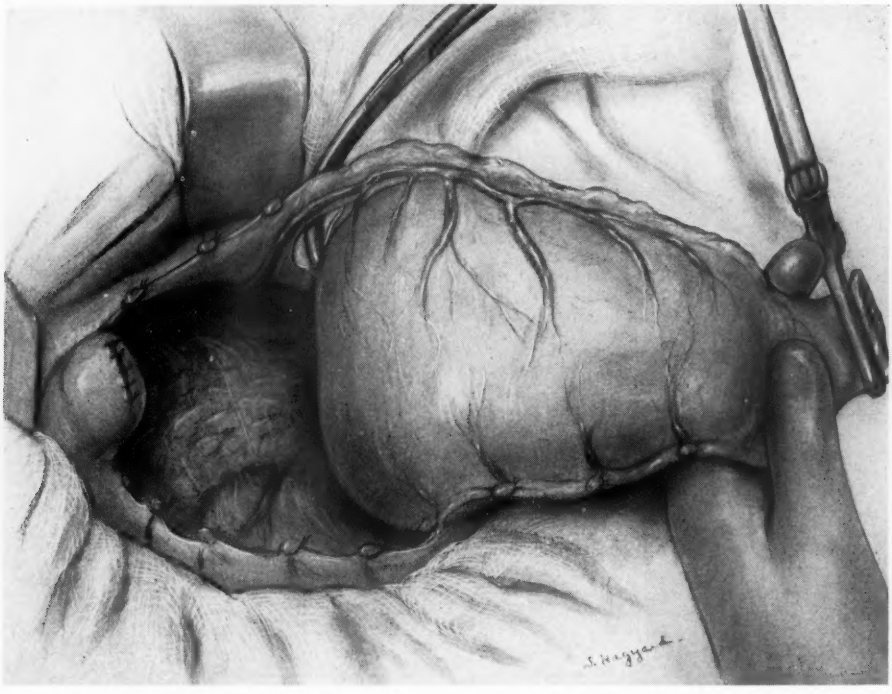


FIG. 6.—The isolation of the left gastric artery.

the stomach in a fold of peritoneum, known as the gastropancreatic omentum.[6] Branches are supplied to the posterior wall of the stomach while the main trunk of the vessel runs toward the cardiac end of the stomach and then loops downward between the two layers of the gastrohepatic omentum where it gives off terminal branches to the lesser curvature. It is obvious, therefore, that ligation of this vessel in the lesser omentum controls only a portion of the blood supply and does not effect complete mobilization of the organ. We have been greatly impressed with the advantages of ligating the left gastric artery close to its origin and sectioning it together with its enveloping ligament, the gastropancreatic omentum, a structure which fixes the stomach in this region. If the stomach is pulled well over to the left after severing the duodenum, the artery and its ligament stand out as a firm cord-like structure which is easily isolated and clamped (Fig. 6).

Amount of Stomach Removed.—In common with all who have had extensive experience with gastric resection for ulcer, we have gradually increased the amount of tissue removed until now we believe that from two-thirds to three-quarters of the stomach should be resected. Certainly, high resections do not carry any greater mortality than the more limited pylorectomies or antrumectomies, and the results as indicated by our follow-up system are infinitely better. We have been impressed with the high incidence of chronic gastritis found in association with duodenal ulcer, and have

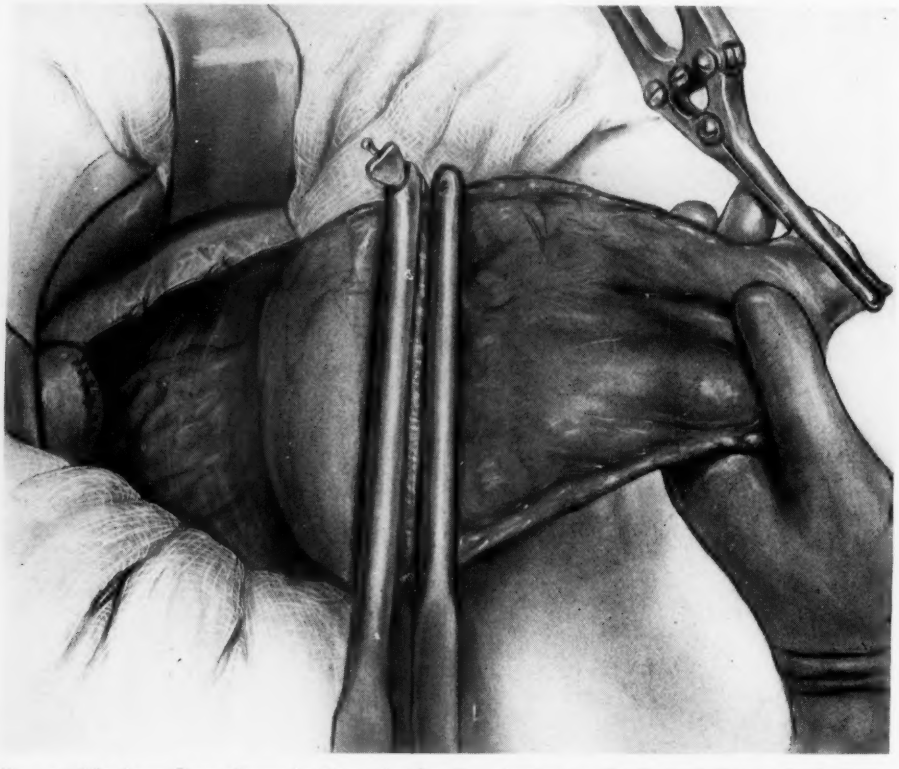


FIG. 7.—The large Payr clamps in place, showing the wing-nut on the jaws of the proximal clamp.

come to believe that the excellent results following partial gastrectomy must be due in no small part to the removal of diseased gastric mucosa. The gain in weight and return of the feeling of well-being experienced by patients subsequent to operation are greater than can be accounted for by simple relief from recurring attacks of gastric distress. This opinion, stressed for many years by European surgeons,[7] has not received the attention it deserves in this country.

We have not had any experience with the dePetz clamp but employ two large Payr crushing clamps, dividing the stomach with a scalpel between them (Fig. 7). The gastric tissue protruding through the proximal clamp is then swabbed with the antiseptic hexyl-chloro-meta-cresol. To overcome slipping of the gastric wall from the Payr clamp in high resections, we have added

a hinged bar threaded with a wing-nut to the tip of the proximal clamp (Fig. 8). After the clamp is closed, the extra pressure exerted by tighten-

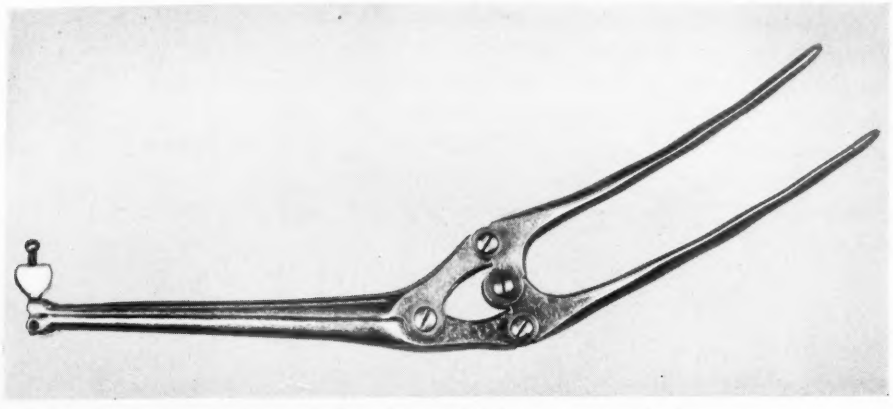


FIG. 8.—The large Payr clamp with the wing-nut on the jaws.

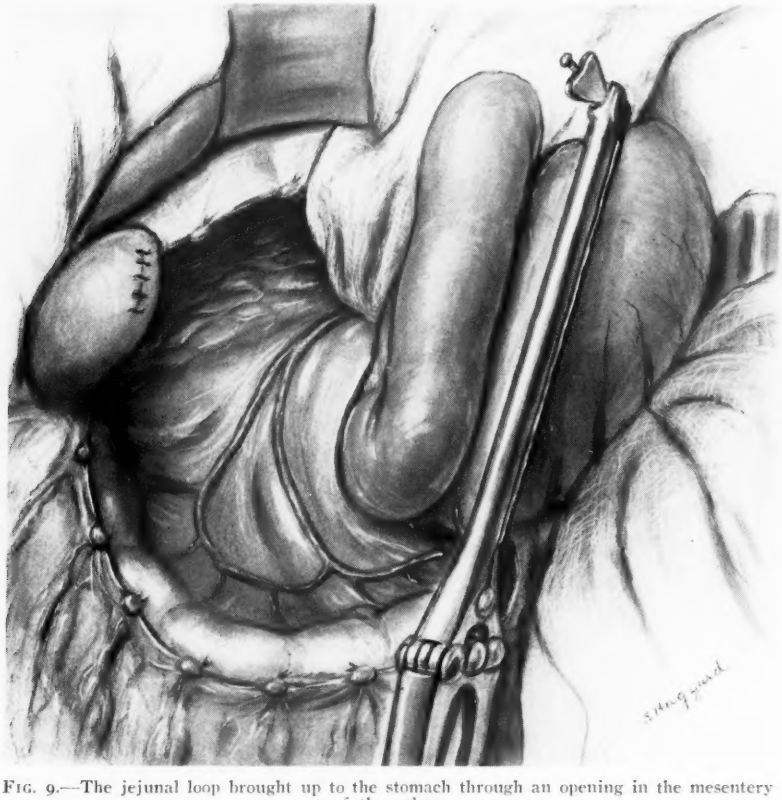


FIG. 9.—The jejunal loop brought up to the stomach through an opening in the mesentery of the colon.

ing the nut is sufficient to maintain a firm grasp on the stomach wall and thus obviates escape of gastric contents.

Relative Position of the Jejunum and Colon.—In spite of the fact that many surgeons[8] now favor the antecolic position of the jejunum, we have continued to bring it through a rent in the mesocolon placed as far as possible from the colonic margin, and so far have had little reason to discredit this method. In the last 50 patients, we have had trouble only once with obstruction to the gastric outlet. At reoperation, a phlegmonous condition of the anastomotic site was found, but we were unable to detect whether it was due to catgut allergy or mild infection. It is true that in this particular

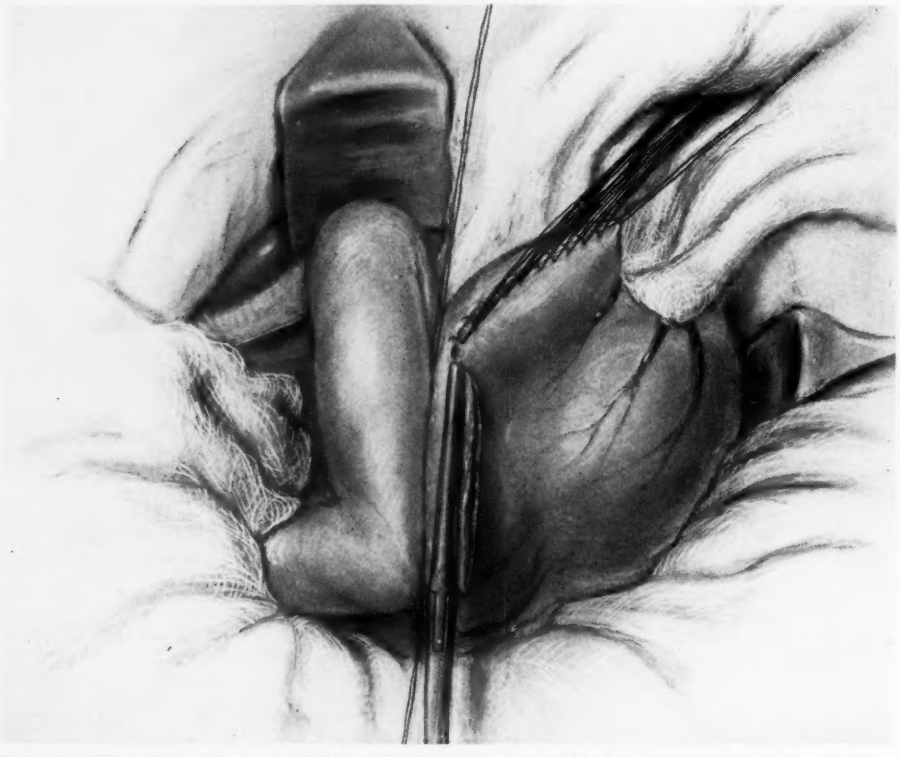


FIG. 10.—The portion of the stomach on the lesser curvature side has been closed. The proximal jejunum has been brought to the lesser curvature and the distal jejunum to the greater curvature.

instance some of the difficulty might have been obviated if an antecolic position of the jejunum had been used, for the mesocolon was very definitely involved in the mass. We leave only just enough jejunum proximal to the anastomosis to guard against kinking when the stomach is allowed to fall back into position, for it appears to us that the closer to the duodenum the anastomosis is effected, the more nearly will be the approach to the normal physiologic relationship of the stomach and small intestine. An isoperistaltic relationship of the stomach and jejunum is maintained by placing the proximal jejunum in apposition with the lesser curvature of the stomach, because the duodenal contents are more likely to be deflected past the gastric stoma than if an antiperistaltic union is made (Fig. 9).

Anastomosis of Stomach to Jejunum.—We now prefer the Hofmeister-Finsterer[9] type of anastomosis, because the valve formed by the closed end of the stomach above the anastomotic stoma deflects the duodenal contents along the jejunum rather than into the stomach as occurs with the Reichel-Pólya[10] technic. This observation has been verified on many occasions by finding that the bile appears in the gastric tube 24 hours later and is definitely less in amount after the Hofmeister-Finsterer anastomosis. Further-

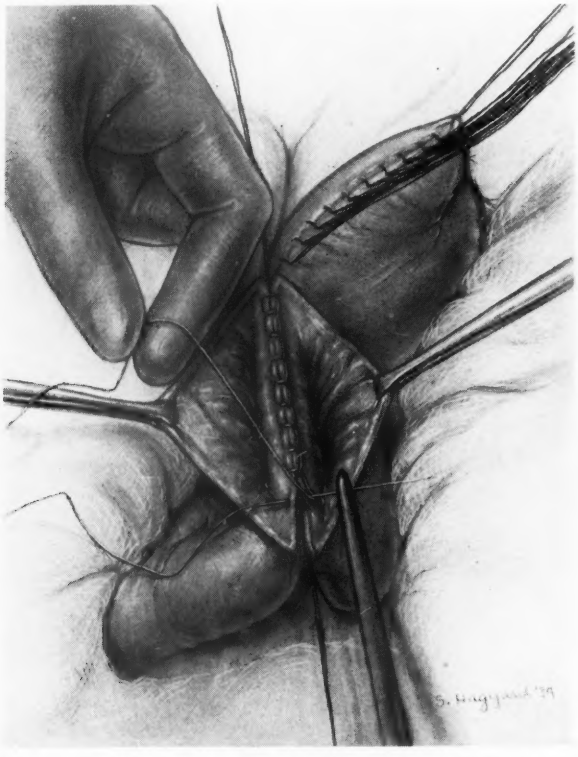


FIG. 11.—The suturing of the posterior wall of the stomach to the jejunum.

more, since abandoning the Reichel-Pólya operation, our patients have not complained of occasional vomiting of bile, a complication that not infrequently occurred with this technic.

In closing the cut end of the stomach above the proposed anastomotic site (Fig. 10), we have found it convenient to commence the interlocking catgut suture at the upper limit of the stoma rather than at the lesser curvature. This provides a fixed point to work from and facilitates the infolding of the upper angle because of the downward traction that can be exerted by the catgut. The suture is then carried back to its starting point, using the continuous Lembert stitch. A second row of interrupted Lembert sutures of fine silk on milliner's needles is then put in, beginning at the lesser curvature and continued down to the proposed anastomotic site. The last two Lembert

sutures of fine silk are not tied, but the ends are grasped with an artery clamp, and they are laid aside until the anastomosis is completed. Tying these two sutures after the anastomosis is made, more effectively closes the so-called dangerous angle. This area receives additional support when the jejunum proximal to the stoma is united to the previously closed end of the stomach.

In fashioning the anastomosis, two points are worthy of attention. The first is to guard against rotation or kinking of the jejunum by using guide

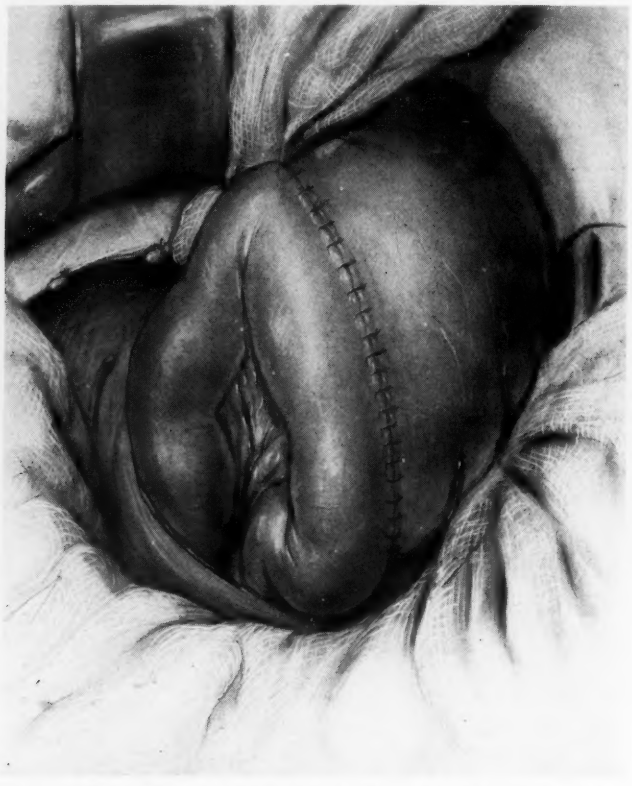


FIG. 12.—The completed anastomosis, showing the reinforcement of the closed portion of stomach by jejunum.

sutures to fix the two ends of the line of suture uniting the stomach to the jejunum (Fig. 11), and the second is to insert the posterior continuous suture between the viscera well toward the mesenteric border of the jejunum so that sufficient jejunal wall remains for the anterior row of interrupted silk sutures after the encircling continuous catgut suture is put in. It is also important when reinforcing the lower angle of the anastomosis to take only small bites with the suture on the jejunal side lest narrowing of the jeunum below the stoma should occur (Fig. 12).

Closing of the Aperture in the Mesocolon.—The opening of the mesocolon is placed as close to the spine as possible and to the left of the main trunk of the middle colic artery to guard against involvement of the colon, should an anastomotic ulcer develop, and to prevent injury to the artery when the open-

ing is closed. We endeavor to pull the completed anastomosis down through the aperture in the mesocolon so as to suture the margins to the stomach and place the anastomosis in the infracolic compartment (Fig. 13). The procedure is impossible in certain high resections and when there is a foreshortening of the mesocolon. Then it is necessary to suture the margins of the aperture in the mesocolon to both the afferent and efferent loops of jejunum and

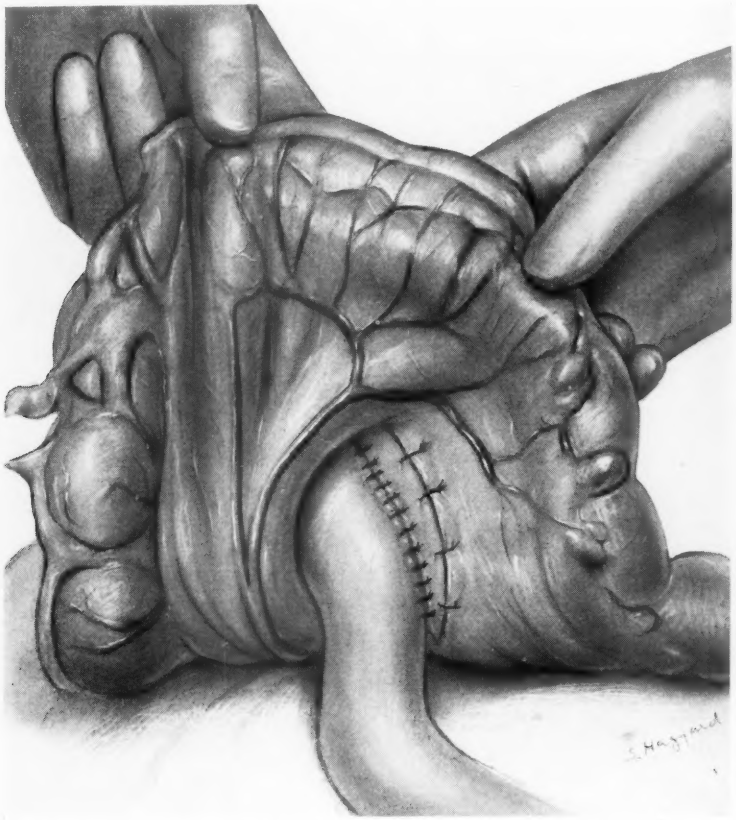


FIG. 13.—The anastomosis is brought down through the opening in the mesentery of the colon, and the rent sutured to the stomach. The proximal loop of jejunum lies behind the distal loop.

also to close the opening between the loops with a purse-string suture of fine silk which should include the edge of the mesocolic opening.

Drainage.—In the usual case, drainage is not necessary, but if a duodenal or gastric ulcer has been left *in situ*, or the pancreas has been injured, or there is any question of the security of the duodenal closure, it is good practice to bring a cigarette drain out through a stab wound at the outer border of the right rectus muscle. All collection of fluid in this area tends to pool in the space between the right kidney and the liver, so the drain should be placed down to this site. If the duodenum leaks and there is no drainage tube, fatal peritonitis is likely to follow, but if the duodenal contents drain externally, the patient's life may be saved.

Postoperative Care.—Continuous gastric suction has solved many of the problems of postoperative care, and we consider that its use constitutes the greatest single advance in surgery of the stomach. We leave the tube in the stomach through the fourth postoperative day, and on the fifth day the tube is clamped off at four-hourly intervals. When the four-hourly residue is less than 100 cc., the tube is removed. During the period the tube is in place, the patient is allowed chipped ice and small amounts of water at frequent intervals, all of which tend to allay thirst and contribute much to the patient's comfort. After removal of the tube, water is given in increasing amounts, and when it is well tolerated, milk and water, half-and-half, are substituted. If all goes well, cream and milk are given at regular intervals, and gradually the diet is increased until the patient is able to take a bland diet. Alkaline powder or amphogel is administered regularly to control any tendency to hyperacidity. It is well to proceed with caution, and if there is any evidence of food intolerance, liquid diet should be restored and then gradually increased. In general, the chief source of difficulty is the tendency to increase the diet too rapidly.

SUMMARY.—A description with illustrations of the authors' method of handling some of the important steps in partial gastrectomy is presented. No attempt is made to consider the operation in full. The discussion is based on the authors' personal experience with the problems.

CONCLUSIONS

The operation of partial gastrectomy is a procedure of some magnitude. Success is due to many factors, chief of which is the personal experience of both the assistant and the surgeon and for which there is no substitute. Secondary factors are the proper anesthetic, prevention of shock during operation, and adequate postoperative care. It is not an operation that should be undertaken by the occasional operator.

REFERENCES

[1] Hartman, F. W., and Schelling, V.: Studies of Hexyl-chloro-m-cresol and Other Carbo-cyclic Antiseptics. Amer. Jour. Surg., **46**, 460–467, 1939.

[2] Jones, W. H.: Spinal Analgesia; a New Method and a New Drug—Percaine. Brit. Jour. Anaesth., **7**, 99–113, April, 1930.

[3] McClure, R. D., Hartman, F. W., Schnedorf, J. G., and Schelling, V.: Anoxia—A Source of Possible Complications in Surgical Anesthesia. ANNALS OF SURGERY, **110**, 835–850, 1939.

[4] Miller, G.: Subtotal Gastric Resection for Peptic Ulcer. Surg., Gynec. and Obstet., **65**, 489–494, 1937.

[5] McClure, R. D.: A Clamp for Closure of the Duodenal Stump in Gastric Resections; a Modification of the Furniss Clamp. ANNALS OF SURGERY, **109**, 1034–1035, 1939.

[6] Ogilvie, W. H.: Approach to Gastric Surgery. Lancet, **2**, 235–239, July 30, 1938.

[7] Konjetzny, G. E.: Chronische Gastritis und Magenkrebs. Monatschr. f. Krebsbekampf, **2**, 65–78, March, 1934.

[8] Marshall, S. F., and Kiefer, E. D.: Partial Gastrectomy for Gastric or Duodenal Ulcer. J.A.M.A., **109**, 1341–1347, October 23, 1937.

[9] Lahey, F. H., and Marshall, S. F.: Surgical Treatment of Peptic Ulcer Based upon

130 Subtotal Gastrectomies for Peptic Ulcer. New England Jour. Med., **217**, 933–940, December 9, 1937.

[10] Finney, J. M. T., and Hanrahan, E. M., Jr.: In Lewis, Practice of Surgery. Hagerstown, Md., W. F. Prior and Co., Inc., **6**, Chap. 8, 1929.

DISCUSSION.—DR. SAMUEL F. MARSHALL (Boston, Mass.): I consider it a pleasure and privilege to have the opportunity of discussing Doctor McClure's paper, because I was with him for so many years before I went to Boston.

In the Lahey Clinic the management of patients with gastric or duodenal ulcer is controlled by the Department of Gastro-Enterology. Consultation with members of the Surgical Staff is obtained for those patients who have failed to obtain relief of their ulcer distress by conservative medical measures, or for those patients in whom some serious complication of chronic ulcer has developed, such as repeated massive hemorrhage, obstruction, *etc.* By this method, surgical management has been necessary in only 8.2 per cent of cases of duodenal ulcers, and in 23 per cent of cases in which a diagnosis of gastric ulcer was established.

Doctor Lahey has always advocated conservatism in the surgical management of patients with ulcer and, because of the magnitude of the operation, has been slow in accepting subtotal resection of the stomach as the method of choice for these patients until it was proven that the best results were obtained by this operation. This is indicated by the gradual increase in the number of subtotal gastrectomies during the past ten years. Ten years ago, of those patients with ulcer who were submitted to operation, 70 per cent had a conservative operation, and 30 per cent had a resection. To-day, 70 per cent have resection, whereas only 30 per cent have conservative operative procedures, an exact reversal. We prefer subtotal resection of the stomach for either duodenal or gastric ulcer, but we do not hesitate to employ gastroenterostomy in a few selected cases, chiefly in those patients who are bad risks for an extensive operation, or in those patients who are past middle age, who have a low gastric acidity and who have a high grade of cicatricial obstruction.

While it may be conceded that the best results from surgical management of ulcer follow high resection of the stomach, the real criterion for its employment is, can this operation be performed with a reasonable margin of safety? Doctor McClure has demonstrated that, with meticulous attention to the details of the operation, the mortality can be kept at a very low level. His report of one death in 53 subtotal resections for ulcer is indicative of this.

Our results following this operation have been somewhat similar to those of Doctor McClure. The most important single factor in reduction of the mortality is experience with this type of gastric surgery, and in most instances this experience has been painfully acquired. A number of years ago, in the Lahey Clinic, our mortality with this operation was 18 per cent—a prohibitive mortality; then it was 11 per cent, and, finally, in our last series of cases, one death occurred in 88 consecutive resections for ulcer. We have included resection for gastrojejunal ulcer in this group.

In addition, then, to the very important factor of experience, meticulous attention to the technical details of the operation makes it possible to perform this procedure with a low mortality. Doctor McClure has emphasized the painstaking care necessary throughout the operation, and we can state, from our own experience, that this is absolutely necessary if a high mortality is to be avoided.

Our technical procedure differs somewhat from the procedure which Doctor McClure employs, but, in the main, these differences are not of great

importance. We employ, almost routinely, a modified Hofmeister method of gastrojejunostomy. It is well to emphasize that if resection is decided upon, it should be radical; at least three-fourths to four-fifths of the stomach should be removed in all instances. The best results follow such an extensive resection, and recurrence of the ulcer is less apt to result after high resection.

We have not prepared our patients before operation with the type of antiseptic that Doctor McClure mentions, and we have had no experience with such an antiseptic. We know that the stomach will sterilize itself rapidly in the presence of normal gastric acidity, and this is particularly true in the presence of high acidity which so commonly accompanies ulcer. Cushing demonstrated this fact years ago. Consequently, we stop all alkaline therapy several days before operation, and as a result can practically eliminate the incidence of infection following operation.

We have employed the dePetz clamp in practically all of our resections. It enables us to reduce the time of the operative procedure; prevents spilling of gastric contents; and controls hemorrhage from the divided end of the stomach.

Another point of interest is whether the antecolic or a transmesocolic anastomosis should be employed. After considerable experience, we have adopted the use of the antecolic gastrojejunostomy. This method reduces the operative time and, in our experience, postoperative obstruction practically never occurs.

It must be remembered that ulcers will recur, even with high resections of the stomach, though fortunately infrequently. Should such an ulcer follow a high resection, it is immeasurably easier to resect if an antecolic anastomosis has been made than if posterior anastomosis has been employed. We, too, routinely employ spinal anesthesia, using nupercain in 1:1,500 dilution, and believe this anesthesia is a considerable factor in increasing the margin of safety.

I think Doctor McClure is to be congratulated upon his excellent results following subtotal resection of the stomach for ulcer.

CHRONIC OBSTRUCTION OF THE PROXIMAL DUODENUM BY CONGENITAL BANDS*

GEORGE H. BUNCH, M.D., AND ROGER G. DOUGHTY, M.D.
COLUMBIA, S. C.

IN 1936, McGehee and Anderson[10] read a paper before this association on "Chronic Obstruction of the Duodenum of Congenital Origin," which they say is a definite pathologic and clinical entity amenable to surgical treatment. As do most writers, they limit discussion to obstruction of the terminal duodenum resulting from imperfect rotation of the intestine so that the duodenum is twisted upon itself or is compressed by the superior mesenteric blood vessels, which causes chronic dilatation of the proximal duodenum demonstrable both roentgenologically and at operation. Madigan[17] reports a case in which the distended second portion of the duodenum filled the pelvis, and in Higgins'[15] 56 cases of duodenal obstruction from all causes the duodenum was found distended in every case.

In contrast to this, we shall briefly report three cases of chronic obstruction of the proximal duodenum from developmental bands derived from the anterior mesogastrium. In none was the duodenum found dilated.

Bland-Sutton has called the duodenum the region of embryonic events. The first portion is derived from the foregut and is comparatively free from extrinsic developmental anomalies. The second and third portions, however, come from the midgut which is, embryologically, the most active portion of the intestine and affords increased opportunity for developmental error. Harris[2] has called attention to the obstructing effect of congenital bands which, crossing the second portion of the duodenum from below, pass upward to the right and terminate in the region of the gallbladder. They are the anomalous remains of the anterior mesogastrium which has failed to follow its development to the normal conclusion. Although found by anatomists long ago, the mechanical effect of these bands on the duodenum has only recently been appreciated by surgeons. Occurring as broad bands of fibrous adhesions lying obliquely across the duodenum, these "cobwebs in the attic" of the infant, although of embryonic origin, are not unlike the adhesions in this region in adult life resulting from chronic inflammation.

In the infant, obstruction of the duodenum may be intrinsic or extrinsic in origin. Complete obstruction is most frequently caused by atresia of the intestine; incomplete, by congenital pyloric stenosis. Both are intrinsic in type in distinction from obstruction by congenital bands which is extrinsic.

Preoperative differentiation in cases of complete obstruction is most often impossible but in incomplete obstruction it can usually be made. Congenital pyloric stenosis, as a rule, occurs in the first male child and symptoms

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

begin in the second or third week after birth. The obstruction being above the ampulla of Vater, bile does not enter the stomach and is not found in the vomitus. Donovan[12] says the pathognomonic olive-shaped tumor mass of hypertrophied muscle may be felt in every case of congenital pyloric stenosis if the examination is made with the stomach empty and the child relaxed. In sharp contrast to this, when the proximal duodenum is obstructed by congenital bands, vomiting starts soon after feedings begin. The vomitus in our three cases contained bile. Pattern-waves, from peristaltic contraction of the stomach wall and projectile vomiting of ingested food, were present in both infants operated upon by us. In none of our cases was the duodenum dilated, for in all, both the first and most of the second portions were hyperfixed and constricted. Dilatation from obstruction develops only in segments of the intestine proximal to an obstruction.

The predominant symptoms are nausea and vomiting, usually beginning with the first feedings of the newborn. If the obstruction is incomplete, there are periods of exacerbation and remission. Persistent gastric stasis in the infant, as in the adult, suggests obstruction, the degree of which may be learned from clinical observation and from roentgenologic study. As the child becomes older, in spite of every care, the clinical picture is that of chronic starvation of varying severity depending upon the degree of obstruction. Sickly and undernourished, the patient instinctively avoids bulky foods. Insufficient food residue causes small, infrequent, scybalous movements rather than true constipation. Older children, after eating, complain of gaseous distention and epigastric distress which is relieved by vomiting.

The prognosis depends upon the degree of obstruction and upon the management of the individual case. When the obstruction is complete, operation is imperative. High intestinal obstruction, from all types of congenital lesions, probably occurs about once in every 20,000 births. Nevertheless, Miller,[9] in 1939, found in the literature only five cases of complete obstruction of the duodenum in the newborn, due to abnormal bands, which recovered. Although, as was shown in the discussion of his paper, he underestimates the true number of successful cases, when the probable incidence is kept in mind the pitifully small number of successes eloquently speaks the need for recognition of the condition. When the obstruction is incomplete, chronic starvation of varying degree may continue even into adult life. Kantor[4, 5] presents correlated roentgenologic and operative findings to support his estimate that 4 to 5 per cent of the cases of epigastric discomfort in adults are due to congenital bands or other anomalies. It is an interesting fact, however, as pointed out by Nook, that most people with anomalies of rotation go through life without ever becoming aware of them.

Symptoms of incomplete obstruction not relieved by medical treatment, continued for a reasonable time, demand surgical exploration. Before operation glucose and normal salt solution should be administered to overcome dehydration and to prevent acidosis. At operation, with the stomach pulled to the left and the liver retracted upward and to the right, the constricting

bands may be demonstrated. They should be cut along the avascular, outer margin of the duodenum as it is mobilized by being gently pulled mesially and to the left. In young infants feeding should be begun early, as after the Rammstedt operation for congenital pyloric stenosis. When free, congenital bands do not seem to reform, and recurrence of the obstruction has not been reported.

CASE REPORTS

Case 1.—Twenty-four hours after a normal delivery, a female infant began vomiting. At the end of 48 hours, the vomiting became projectile in type and contained food particles stained a deep yellow. When seen on the third day, the upper abdomen was distended and the stomach visibly outlined. Typical peristaltic waves passed from left to right, but no mass could be palpated. The obstruction was thought to be below the level of the ampulla because the vomitus contained bile.

At operation, the gallbladder, duodenum and transverse colon were adhered and the stomach distended due to duodenal obstruction. The adhesions were freed and the first portion of the duodenum released from bands which flattened and obstructed it. There were additional adhesions along the second portion which were also released. The postoperative course was uneventful and to date, four years later, the patient has remained well.

Case 2.—R. M. S., a bottle fed boy, age six months, the mother's first child, was admitted to the Columbia Hospital, for the relief of vomiting and progressive loss of weight. He had always been constipated and had vomited often. After being treated by a pediatrician at the age of three months, he improved but after five months continuously lost weight from vomiting. Fluoroscopic examination showed barium passing very slowly through the duodenum, instead of rapidly as in the normal infant. There was almost 50 per cent retention in the stomach after five hours.

At operation, the first and second portions of the duodenum were found flattened and partially obstructed by fibrous bands passing across them from the transverse colon to the under surface of the liver. These were freed. Postoperatively, the patient has had complete relief from digestive symptoms and is well to-day, three years after operation.

Case 3.—J. S., a boy, age 11, entered the Columbia Hospital, complaining of persistent vomiting. He was an only child. His mother gave the significant history that he had vomited every day of his life. As an infant he nursed greedily and after a few minutes vomited. He had repeated attacks of rickets and of acidosis. As a child his appetite was poor and solid food made him ill.

Physical examination on admission was negative, except for pallor, weakness and emaciation. The abdomen was flat and without tenderness or masses. The hemoglobin was 60 per cent. Fluoroscopic study of the stomach after ingestion of barium showed marked retention with incomplete obstruction at or near the pylorus.

Surgical exploration, under ether anesthesia, was performed through a right rectus incision. The first and second portions of the duodenum were partially obstructed by transverse fibrous bands which extended to the under surface of the right lobe of the liver. The duodenum was constricted and flattened, being pulled upward, and somewhat angulated. The pylorus was normal. As the bands were separated and the duodenum mobilized, the intestine assumed its normal position and contour. Following operation there never was any nausea. The patient enjoyed his meals for the first time in his life, and has been normal in every way during the eight years since operation.

In summary, we wish to call attention to the fact that Case 1 had at birth complete chronic obstruction of the proximal duodenum by congenital bands. Early operation, we feel, undoubtedly saved the baby's life. Cases 2 and 3

had incomplete obstruction, and were six months and 11 years old, respectively, at the time of operation. They had both reached a severe degree of chronic starvation before being subjected to exploration, in spite of the fact that in both, symptoms suggestive of obstruction had been continuously present since birth. Both had been repeatedly under the care of well-known clinicians who had vainly sought relief by dietary methods.

While we are admittedly dealing with a rare condition, we are convinced that the rôle played by congenital anomalies of the intestine in chronic digestive disorders is not appreciated. We believe there have been many lives lost in infants because of the failure to recognize the mechanical obstruction as the cause of vomiting and because of unwise and unwarranted persistence in dietary regimen. In our opinion, many young adults are, also, similarly mistreated.

We urge the judicious employment of the barium meal for the recognition of high obstruction. However, when involvement is lower in the intestinal tract the danger of precipitating an acute obstruction by the ingestion of barium must be considered. The necessity for surgical exploration in cases with obstructive symptoms that do not respond to medical treatment we think is so obvious that it is mandatory.

REFERENCES

[1] Buchanan, E. P.: Congenital Duodenal Obstruction from Anomalous Mesenteric Vessels. Am. Jour. Surg., **30,** 499–501, December, 1935.

[2] Harris, M. L.: Constrictions of the Duodenum Due to Abnormal Folds of the Anterior Mesogastrium. J.A.M.A., **62,** 1211, April 18, 1914.

[3] Jackson, R. H.: Congenital Constriction of the Duodenum Due to an Abnormal Fold of the Anterior Mesogastrium. ANNALS OF SURGERY, **84,** 723–728, 1926.

[4] Kantor, J. L.: Practical Significance of Digestive Tract Anomalies. Jour. Michigan Med. Soc., **30,** 820–828, November, 1931.

[5] Kantor, J. L.: Common Anomalies of Duodenum and Colon; Their Practical Significance; Result of Eight Years' Combined Clinical and Roentgen Study. J.A.M.A., **97,** 1785, December 12, 1931.

[6] Kelly, J. F.: Partial Intestinal Obstruction Due to Congenital Anomaly of Duodenum, and Partial Rotation of Colon. Am. Jour. Surg., **22,** 299–302, November, 1922.

[7] Kellogg, E. L.: Abnormalities in the Shape and Position of the Duodenum. Am. Jour. Surg., **12,** 462–465, June, 1931.

[8] Kellogg, E. L., and Collins, J. T.: Congenital Duodenal Obstruction. Am. Jour. Surg., **30,** 369–371, November, 1935.

[9] Miller, E. M.: Bowel Obstruction in the Newborn. ANNALS OF SURGERY, **110,** 587–605, October, 1939.

[10] McGehee and Anderson: Chronic Obstruction and Dilatation of the Duodenum. Trans. South. Surg. Assn., **49,** 111, 1936.

[11] Morton and Jones: Obstruction about the Mesentery in Infants. ANNALS OF SURGERY, **104,** 864, November, 1936.

[12] Donovan, E. J.: Congenital Hypertrophic Pyloric Stenosis. Am. Jour. Surg., N. S., **39,** 377, February, 1938.

[13] Jones and Morton: Congenital Malformation of the Intestine in Children. Am. Jour. Surg., N. S., **39,** 382, February, 1938.

[14] Ladd, W. E.: Congenital Duodenal Obstruction. Surgery, **1,** 878, June, 1937.

[15] Higgins, C. C.: Chronic Duodenal Ileus. Arch. Surg., **13,** 1, July, 1926.

[16] Marx, R.: Nonrotation of the Intestine. ANNALS OF SURGERY, 109, 49, January, 1939.
[17] Madigan, J. P.: A Case of Megalostria and Megaduodenum. South. Med. Jour., 24, 939, 1934. Quoted by Jones; Int. Abs. Surg. (in Surg., Gynec. and Obstet.), 63, 420, November, 1936.

DISCUSSION.—DR. L. W. GROVE (Atlanta, Ga.): I would like to present two cases to emphasize two points: First, as suggested by Doctor Doughty and recently by Doctor Ladd, that anomalies of the gastro-intestinal tract are much more frequent than we realize, and that while definite anomalies may exist they often present no symptoms until complicated by some acute abdominal pathology; and, second, to call attention to a very unusual complication arising in a case of acute lymphatic leukemia.

CASE REPORTS

Case 1.—The first case came to us in 1933, a young woman, age 19, in perfect health until two months before admission to the hospital, at which time she suffered an acute abdominal catastrophe, diagnosed, and I think correctly, as acute mesenteric adenitis. Following this she began to have recurrent attacks simulating a high intestinal obstruction. A roentgenologic study confirmed the diagnosis of a partial obstruction high in the jejunum. It also showed a nonrotation of the colon. These findings were confirmed at operation. The cecum had not rotated beyond the midline. It was behind the small bowel which was rotated to the left on the superior mesenteric root, with loops of jejunum adherent to nodes in the roots of the mesentery at several points, causing multiple points of partial obstruction. The small bowel was freed at these points and rotated into normal position. The cecum was then rotated and fixed in its normal position. She has had no further trouble.

Case 2.—The second case was a child, two years old, who came under observation two years ago. Apparently, she had been well until two weeks before admission, at which time there was evidence of acute tonsillitis, accompanied by vomiting. The tonsillitis quickly subsided but she continued to vomit. There were enormous amounts of bile in the vomitus and, apparently, very little food was passing through the stomach. At this time, roentgenologic examination was made, which showed definite obstruction with marked six-hour gastric retention. At the end of 24 hours, there was almost complete obstruction of the third portion of the duodenum. She was operated upon, and there was found almost complete obstruction of the duodenum caused by pressure from the superior mesenteric vessels. In this area there were several mesenteric nodes matted together, which caused complete fixation of the mesenteric root. A duodenojejunostomy was performed, without clamps. Her convalescence was uneventful, without further vomiting, and she was dismissed from the hospital at the end of two weeks. Two months later, she was readmitted. Examination revealed a generalized adenopathy, a high temperature, purpuric spots and a blood picture diagnostic of an acute lymphatic leukemia. Unfortunately, autopsy was not obtained. The enlarged mesenteric nodes found at operation were probably the first evidence of the leukemia, which was not recognized at that time.

DR. K. H. AYNESWORTH (Waco, Tex.): I have, for a long time, been very much interested in the embryologic significance of this region. We know that, in the evolution of man, many changes took place which have pathologic significance. Some of these changes are similar to the scaffolding of a building, useful in construction, but should be removed when the building is completed. There are embryologic adhesive bands in the region of the gallbladder and duodenum which, later, may cause trouble by obstructing the bowel and end in tragedies. In a pronograde animal, the mesenteric attachment is simple, and along the dorsal spine. When the ancestral man assumed the upright position, there were many supporting structures devised to hold

the intestines and viscera in correct position, some of which were defective and others were of possible pathologic significance.

Roughly speaking, the foregut is a region which prepares the food for digestion. The midgut is the region which continues the chemical action upon the food which began in the foregut, and the hindgut expells the remains of both food and secretions poured into the bowel. The rotation of the intestines begins with the embryologic development about the fourth week and ends about the tenth week. Rotation and fixation of the intestines begin at the upper end of the small intestine and rotate to the left. When doing so, there are many adventitious bands which form in this region and the remains of these are the ones which produce obstruction in later life.

Dr. Roger Doughty (Columbia, S. C., in closing): I think we have nothing to add, except that we wish to thank the gentlemen for their discussion. If we have drawn attention to the lesion in such a way as will in future assist in early recognition of the condition, I think that we have accomplished our purpose.

NONMALIGNANT OBSTRUCTION OF THE INTESTINE*

MICHAEL JOSEPH HENRY, M.D.
LOUISVILLE, KY.

DURING the past few years the manner of dealing with intestinal obstruction due to carcinoma or other malignant growths has become fairly well standardized. It does not present the wide variety of causative conditions; its onset is less frequently sudden; and its end-results are determined more by the degree of involvement of neighboring or distant structures, than by the extent of the obstruction. In malignant obstruction one rarely has to deal with alterations in the circulation to the bowel above the obstruction, while in those cases due to nonmalignant causes the blood supply to the tissues above the point of blockage is frequently the chief factor in determining the outcome. Nonmalignant and malignant obstruction cannot be well considered in any brief article. For this reason I shall confine my discussion to the results obtained in our series of intestinal obstruction due to nonmalignant conditions. I shall further confine it to those cases subjected to surgical treatment.

The advent of the catheter-like duodenal tube, which can be introduced transnasally, has brought about a marked change in the methods of dealing with the various types of ileus. Since its introduction many cases formerly thought to demand surgical treatment for their alleviation now can be completely relieved, or put into such condition that any operative measures to overcome the effects of stasis can be undertaken with less risk. This is particularly true in those cases of adhesive obstruction resulting from a recent operation.

In the postoperative course of abdominal procedures there often occur instances of distention and vomiting, with or without pain. These frequently tax the judgment of the surgeon when he tries to determine whether or not an obstruction exists, and if existent, whether or not it is complete. Prior to the use of the duodenal tube many of these were subjected to operative interference, which, if they occurred to-day, could be relieved by prolonged tubal drainage of the upper intestinal tract.

A duodenal tube may be easily introduced through the nose, into the stomach, from which it passes into the upper intestinal tract. Very satisfactory decompression of the tract can be effected when suction is applied to this tube. We use the Foss apparatus to produce this suction and have found it very simple and satisfactory.

We have had a very limited experience with the use of the Miller-Abbott tube. The reports of those who have had more experience in its use seem to indicate that in cases of obstruction it will prove a valuable addition in the treatment. Paralytic ileus is, perhaps, the most promising field for its use.

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

Any procedure which can reduce the mortality in cases of interruption in the continuity of the bowel lumen will prove welcome to every surgeon. A study of our own cases shows that the mortality under the older methods is high. The high mortality should, when possible, lead one to the now more conservative methods of dealing with these cases.

The use of the conservative measures to treat cases of ileus will call for much more accurate diagnoses, since the problem of some major interference with the circulation in the distended bowel will demand the use of the highest degree of discrimination. While it is true that abdominal tenderness does give some information as to the condition of the intestinal wall, the occurrence of obstruction soon after operations for inflammatory lesions finds an abdomen that has not been free of tenderness since the onset of the primary disease, and thus lessens the value of this finding in cases presenting impaired circulation.

Unless one occasionally looks critically at the record, one is likely to hold erroneous views as to one's own success or failure in any field.

For the purpose of determining our results in the surgical treatment of nonmalignant obstruction, I have reviewed the histories in our own files. Seventy per cent of these cases were operated upon by Dr. Irvin Abell; the remainder by me. Since I have been associated with Doctor Abell for nearly 25 years, more than 90 per cent of the cases have come under my observation.

All the cases considered in this study are of the complete or almost complete type. Ninety-one per cent were of the complete variety. Obstructions of mild or moderate degree and those treated conservatively have not been included.

In this series, pain and vomiting were present in more than 95 per cent of the cases. The frequent occurrence of vomiting is, no doubt, due to the fact that so many of the patients had obstructions to the small intestine, and many came to the hospital long after the onset of obstructive symptoms. Distention was the next most frequently encountered finding, but in our series it was not of sufficient frequency or degree to be of diagnostic importance.

The length of time elapsing between the onset of symptoms and the institution of treatment is shown in Table I.

TABLE I

HISTORIES STATING TIME OF ONSET (124)

	No. of Cases
Less than 12 hours	12
From 12 to 24 hours	27
From 24 to 48 hours	24
From 2 to 5 days	35
More than 5 days	26
Total	124

Thus 70 per cent were seen more than 24 hours after the onset of the obstruction.

The causes of obstruction in which neoplastic disease is not a factor are shown in Table II.

TABLE II

OBSTRUCTION NOT CAUSED BY NEOPLASM

	No. of Cases
Adhesions a factor	84
Due to adhesions alone	74
Adhesive bands present	37
External herniae	54
Volvuli	11
Gallstone obturation	7
Intussusception	11
Tuberculosis	4
Mesenteric thrombosis	2
Imperforate anus	1

From Table II it will be seen that adhesions played a part in the production of the symptoms in 46 per cent of the cases, and were the sole cause in 40 per cent. External herniae were responsible for 30 per cent of the obstructions.

In cases of obstruction due to neoplastic disease the large bowel is more frequently the site of the offending lesion, while in the nonmalignant group the reverse is true, as is seen from Table III, which shows the location of the obstruction in this series:

TABLE III

SITE OF OBSTRUCTION IN NONMALIGNANT CASES

	No. of Cases
Jejunum	9
Ileum	134
Cecum	2
Ascending colon	1
Transverse colon	7
Descending colon	1
Sigmoid	5
Rectum	1
Total	160

In explanation of the large number of cases occurring in the ileum, it might be stated that in many records the only notation as to localization is that the obstruction was in the small intestine. When the complete record did not indicate the jejunum to be the involved segment, the obstruction has been tabulated as occurring in the ileum. Duodenal obstructions have not been considered in this group of cases because they are so frequently indistinguishable from pyloric obstructions.

The laboratory gives very little aid in the recognition of the presence of obstruction. The more pronounced the obstruction the less importance is to be placed upon laboratory findings. In the incomplete or chronic type of obstruction is found the greatest usefulness of the laboratory, since a study of the chemistry of the blood may help to disclose its presence.

Blood counts and stained smears of the blood yield little information. In extreme dehydration the hemoglobin content may be high, and there may be a high red cell count. The leukocyte count yields no more information than does the study of the red cell and hemoglobin content, for dehydration or the presence of the disease which caused the obstruction interferes with the accurate interpretation of the study of the leukocytes. In our series, blood counts, including differential studies, were made in practically all cases, yet no definite information is gained by a comparative study of the findings obtained.

Roentgenologic examination is of some aid in the diagnosis of obstruction, but in this series it was employed too infrequently to justify the drawing of any conclusions from this source of information.

As 91 per cent of the obstructions in this series were of the Grade 4 variety, the roentgenogram could have done no more than aid in the localization. Many of our cases occurred before we were aware of the possibilities of obtaining information in this manner.

Recently, we have employed roentgenologic examination in cases of suspected obstruction. We prefer to make the exposures in two positions. The roentgenogram taken in the supine position will show the distended bowel, and by the position of the distended loops one can conjecture as to the location of the lesion producing the blockage. That taken in the upright, or even semiupright, posture gives some information not obtained by the other exposure. Obstruction in the lower ileum sometimes shows a distended bowel which is hard to identify on the film taken in the supine position, since the distention is sometimes so great as to give the impression of a distended loop of colon. Since, in colonic obstruction, there is frequently little or no distention of the small intestine, the presence of many stair-step shadows of fluid and gas, which are much better shown in the upright position, indicates that the obstruction is in the small intestine.

The mortality in intestinal obstruction is high under any circumstances, and when one is considering cases of such severity as to demand surgical intervention, the mortality is correspondingly higher.

Adhesions.—In our series of cases the most frequent causative factor was the presence of adhesions, either of the sessile type, or that characterized by the formation of bands.

Adhesions were the sole factor in 74 cases, and of these, 44 gave a history of previous abdominal operations. These operations were equally divided between the recent and remote ones. The mortality in the various types is shown in Table IV.

TABLE IV

MORTALITY FOLLOWING OBSTRUCTION BY THE VARIOUS TYPES

All adhesion cases	27 per cent
No previous operation	33 per cent
With previous operation	23 per cent
Operation recent	27 per cent
Operation remote	18 per cent

Of the 20 fatal cases in this series, nine required intestinal resection.

It is evident that the most favorable type of adhesive obstruction is that coming late after previous operation. This is probably due to the fact that the general practitioner recognizes the danger of obstruction in persons having abdominal scars, and consequently sends the patient to the surgeon with less delay. Also, there is less likelihood of encountering infection in the remote case.

Following the same line of reasoning, the high mortality rate in those cases with no surgical scars on the abdomen is more likely due to the fact that there is a delay in their reaching the surgeon, often having been treated for "acute indigestion," "gas colic," or perhaps gallbladder disease before the true condition is ascertained.

External Herniae.—In dealing with external herniae, one would be justified in expecting a relatively low mortality, which is true. Yet, with such an apparent condition the mortality is too high. No doubt, this can be attributed to the fact that the patient has frequently succeeded in reducing a hernia even after much effort—which gives him a false sense of security, causing him to delay calling a physician. To his error is often added that of the physician, who makes prolonged efforts at reduction, with or without an anesthetic. Such efforts cause delay and traumatize a bowel wall that is easily damaged, bringing about an increase in the seriousness of the operative procedures eventually employed.

In this series there were 54 cases of obstruction due to strangulated hernia. Fifty-three of these were operated upon, with ten deaths, giving a mortality of 19 per cent. These herniae were divided as shown in Table V.

TABLE V

DISTRIBUTION OF STRANGULATED HERNIAE

	No. of Cases
Right inguinal	22
Left inguinal	8
Right femoral	11
Left femoral	5
Umbilical	2
Incisional	6
Total	54

Of the ten cases terminating fatally in this group, four required resections of the bowel, which indicates the seriousness of the lesion. One case of sim-

ple release of the incarcerated intestine, with a repair of hernia, died of a pulmonary embolus on the eleventh postoperative day.

From the rather high mortality, which is usually the mortality of delay, one sees the necessity of cautioning all those who have herniae that with the development of severe pain in a previously quiet hernia surgical relief should be sought without delay. Especially should this be impressed on the medical profession.

Internal Herniae.—Three of the cases listed under those due to adhesions were in reality herniations into surgically formed pockets within the abdomen. Two followed operations to suspend the uterus. Both were performed by the method of Gilliam. One followed an operation for prolapse of the cervix with cystocele and rectocele. The body of the uterus had been removed years previously. In correcting this prolapse, bands of the rectus fascia had been brought through the peritoneum and sutured to the cervical stump, thus dividing the entrance to the pelvis into three openings through which loops of intestine could herniate.

Volvulus.—Eleven cases of volvulus were seen. One was found at necropsy in a patient dying soon after admittance to the hospital. Of the 10 cases operated upon, five died, a mortality of 50 per cent. The five patients who lived following operation required no more than a simple release of the volvulus. The fatal cases were subjected to the following types of operation (Table VI).

TABLE VI

OPERATIVE PROCEDURES IN THE FATAL CASES

Enterostomy	1
Release plus enterostomy	1
Closed resection; Rankin clamp	1
Resection plus enterostomy	1
Not stated	1
Total	5

Gallstone Obturation.—Obturation obstruction is rarely diagnosed preoperatively. There were seven cases due to this cause. One was found at necropsy, in a patient who entered the hospital in a moribund condition. Six were found at operation. Of these, three died, a mortality of 50 per cent.

There is no class of cases that should offer a better field in which to use tubal drainage of the upper intestinal tract. Since the pathologic process is one of simple blockage, were one able to get the tube beyond the fistula between the gallbladder and intestinal tract, simple decompression should soon render operative removal of the obstructing object a comparatively safe undertaking.

Intussusception.—Of this type of obstruction there were 12 cases. One was found at necropsy as being due to invagination of a Meckel's diverticulum which had produced the intussusception in the same manner as does a polyp.

There were 11 operative cases, four of which resulted fatally, a mortality of 36 per cent (Table VII).

TABLE VII

TYPES OF INTUSSUSCEPTION

Types of Intussusception:	No. of Cases
Enteric	2
Ileocolic	4
Ileocecal	3
Colic	3
Total	12
Age Incidence:	
Less than nine months	6
Twenty-one months	1
Four to ten years	4
Eighteen years	1
Total	12

In the diagnosis of intussusception the presence of blood in the stool is of great importance. In this series there were only eight cases whose records definitely stated whether or not blood was present. Seven showed that blood had been passed per rectum, while one referred to its absence.

Tuberculosis.—There were three cases of obstruction due to adhesions resulting from tuberculous peritonitis, and one due to a tuberculoma of the cecum.

The operative procedures carried out in the four instances were: Release of the obstruction, 2; ileocolostomy, 1; cecocolostomy, 1.

There was one death. It occurred in a patient for whom a simple release of the obstruction had been performed.

Mesenteric Thrombosis.—There was one case of thrombosis in the jejunum. This patient survived a resection of the jejunum with a lateral anastomosis. One case of thrombosis of the ileum died, following a resection performed by the Rankin clamp method.

Imperforate Anus.—The only case of this type of obstruction occurring in our series was in a premature baby, weighing three pounds. It was operated upon 31½ hours after birth. There were no skin markings to denote the location of the sphincter. The bowel was found 2 cm. above the levators, and its mucosa was sutured to the skin. The child was in good condition when it left the hospital with its mother on the eleventh day postpartum.

From a study of our records it is evident that the type of operation required determines the percentage of mortality. This may be seen from the statistics in Table VIII.

Resections were required in 30 cases, and resulted in the death of 17 patients, a mortality of 57 per cent.

These resections were performed in the following types of obstruction:

TABLE VIII

TYPES OF OBSTRUCTION IN WHICH RESECTIONS RESULTED FATALLY

Adhesions	6
Adhesive bands	3
Intussusception	2
Inguinal herniae	2
Femoral herniae	2
Thrombosis	1
Volvulus	1

Enterostomy alone was performed in three instances. All died. A necropsy on one of these patients showed the presence of a volvulus.

Twenty-eight cases were treated by releasing adhesions and performing an enterostomy above the site of obstruction. Of these, 11 died, a mortality of 39 per cent.

Those cases requiring no more than a release of the adhesions producing obstruction were, as would be expected, the most favorable group. In this class there were 48 cases. Eight of them died, a mortality of 17 per cent.

A review such as this, which shows the high mortality present in the radical treatment of obstruction, must result in a correlation of these data with the results obtained under the present methods of dealing with this serious lesion.

Tubal decompression of the intestinal tract should lessen the indications for the operative treatment of obstruction and bring patients to the operating room in much better condition to withstand the hazard of an operation for intestinal ileus.

DISCUSSION.—DR. JAMES D. RIVES (New Orleans, La.): I would like to say a few words about the pros and cons of the treatment of intestinal obstruction by means of the various types of indwelling catheters. Before doing so, I wish to make it clear that I believe that the mortality of intestinal obstruction depends more upon the time elapsed between its onset, and its relief, than on any other factor, and that any treatment which does not take this fact into consideration will fail.

When the Wangensteen method of continuous aspiration of the intestine was introduced a few years ago, it was adopted in the Charity Hospital at New Orleans with a certain degree of overenthusiasm, by the relatively inexperienced members of the staff. In a period of three years, nine patients whose intestinal tracts had been adequately decompressed by this method died as a result of perforation at the point of obstruction with resulting peritonitis.

In contrast, I would like to report the cases collected at Touro Infirmary by Doctors Kaplan and Michel. There were 17 cases of various types of ileus in which an attempt was made to relieve the obstruction by means of the Miller-Abbott tube. These cases were supervised by a relatively more experienced personnel, with roentgenologic observation of the introduction of the tube, special nursing care, and the practically constant attention of residents and interns. In the 17 cases in which introduction of the tube was attempted, it was successfully passed beyond the pyloric sphincter in 14. Two

of the failures were in young children. Bowel function was restored and free bowel movements occurred in all 14 cases where successful introduction was accomplished.

There were four deaths in the series. One had been obstructed for four days at the time of admission. Introduction of the tube was not accomplished, and operation failed to save the patient. In three, death resulted from various complications after release of the obstruction. There were no deaths that we feel were attributable to the use of the tube, although there were two rather narrow escapes. In one, the ultimately necessary operation was deferred for 48 hours. Another died with pneumonia, and it was found at autopsy that overinflation of the balloon of the tube had produced excessive distention of the bowel and that necrosis had begun. Had she not died of pneumonia, she would probably have died of intestinal perforation. Since that time, we never permit the introduction of more than 40 cc. of air. I should say that most of these cases were recent obstructions, by which I mean that they occurred during hospitalization following various abdominal operations. These, I think, are the cases in which the method is least likely to get us into trouble because strangulation is unlikely to occur. When the Miller-Abbott tube is successfully introduced, bowel movements will usually occur within 12 hours after it has passed the pylorus. If this does not occur, it is unsafe to continue the treatment without operation because it is probable that the obstruction is of such a character that strangulation is likely to take place.

Dr. Edward V. Mastin (St. Louis, Mo.): I was very interested in Doctor Henry's paper and would like to report the case of a girl, five and one-half years old, who had had three attacks of acute intestinal obstruction due to intussusception during a period of ten months.

At the first operation the obstruction was relieved and her appendix, which was acutely inflamed, was removed. The ileum was sutured to the side of the cecum. The second attack occurred three months later and required surgery. At this operation it was very difficult to reduce the intussusception and no additional surgery seemed justified as the child was quite ill at the time. The third attack took place seven months later and, at operation, it was found that three and one-half feet of ileum had invaginated into the cecum and ascending colon. After the intussusception was reduced, I split the peritoneum over the lateral portion of the abdominal wall and scarified the cecum with gauze, then sutured it to the lateral abdominal wall with interrupted sutures of silk so that it was thoroughly fixed. It has been a year and eight months since the last operation and the child has had no further attacks of intussusception.

Dr. M. J. Henry (Louisville, Ky., in closing): I should like to mention a case in which I used amniotic fluid: The patient was a boy, age 12, upon whom I operated for intestinal obstruction four times within a period of two months.

The first attack of ileus was one year after a simple appendicectomy. It was due to a band of adhesions. The band was excised, and the convalescence was smooth until the twelfth day, when he developed signs of acute intestinal obstruction. This time there were many loops of intestine adherent to one another. These adhesions were freed and before closing the peritoneum 50 cc. of "Amfetin" were poured into the cavity. He left the hospital on the fourteenth day after the operation. In a week or so the bowel was again obstructed. Then it was that I had the opportunity to observe the effect of

amniotic fluid upon the peritoneum. The whole cavity looked as if fine white feathers had been scattered in it. No free loops of intestine were seen. The obstruction was due to very dense adhesions at one point. These could not be separated. A resection of about 18 inches of ileum was performed. The anastomosis was the end-to-end type, using a Rankin clamp, and an enterostomy was made above the anastomosis. In a couple of weeks after an uneventful convalescence he had the fourth attack of ileus. This time I was able to overcome the obstruction by merely separating the adhesions. In desperation I again used the amniotic fluid; using 200 cc. instead of the 50 cc. used previously. He later developed a subphrenic abscess, which required drainage posteriorly. Although the appearance of the peritoneum at the fourth operatior for ileus gave promise of further trouble, the boy has been perfectly well during the past three years.

PENETRATING WOUNDS OF THE ABDOMEN*

AN ANALYSIS OF FORTY-SIX PERSONAL CASES

AMBROSE H. STORCK, M.D.

NEW ORLEANS, LA.

FROM THE DEPARTMENT OF SURGERY, SCHOOL OF MEDICINE, TULANE UNIVERSITY, NEW ORLEANS, LA.

MEMBERS of the Southern Surgical Association who have previously reported on penetrating wounds of the abdomen and the dates of their publications include: Miles,[1] of New Orleans, in 1887; Parker,[2] of New Orleans, in 1896; McRae,[3] of Atlanta, in 1898; Crofford,[4] of Memphis, in 1899; Grant,[5] of Louisville, in 1899; Wysor,[6] of Clifton Forge, in 1901; Fenner,[7] of New Orleans, in 1901; Neff,[8] of Washington, in 1901; Caldwell,[9] of Cincinnati, in 1905; Guerry,[10] of Columbia, in 1907; McRea,[11] of Atlanta, in 1908; Mason,[12, 13] of Birmingham, in 1922 and 1923; Bunch,[14] of Columbia, in 1928; Willis,[15, 16, 17] of Rocky Mount, in 1931 and 1934; Wilson,[18] of Birmingham, in 1934; and Storck,[19] of New Orleans, in 1938. The Charity Hospital in New Orleans, from which the material for this present report was derived, has also been the source of material for the studies on the same subject, which have been made by Miles,[1] Parker,[2] Fenner,[7] Matas,[20] Loria,[21, 22,23] Miller,[24] and Storck.[19] Recent publications concerning penetrating wounds of the abdomen, some of which are based on the recent Spanish and current Sino-Japanese wars, include those by Bastos,[25] Butler,[26] Capruci,[27] Cubbins and Scuderi,[28] Culligan,[29] Gomez Durán,[30] Gilorteanu and Gostescu,[32] Guillaume-Louis,[33] Jones,[34] Kreuschner,[35] Lanzillo,[36] Maass,[37] Meyer and Shapiro,[38] Mitchiner,[39] Bergos Ribalta,[40] Shipley and Hamrick,[41] Taylor,[42] Gordon-Taylor,[43] von Miorini,[44] Wershub,[45] and Wright, Wilkinson, and Gaster.[46]

In a previous communication,[19] observations concerning gunshot wounds of the abdomen based on 35 cases managed in civil practice were reported. The present discussion of penetrating wounds of the abdomen is based on 46 cases, including the 35 gunshot wound cases previously reported and, in addition, 11 penetrating stab wounds of the abdomen, one of which resulted from impalement. All cases of known or suspected penetrating wounds of the abdomen which were encountered during the period of this report were subjected to celiotomy with the exception of those patients who, at the time of admission, were moribund as a result of exsanguinating hemorrhage, or irreparable damage of the abdominal wall and viscera resulting from close range shotgun injuries; and those cases in which the elapsed time since injury was so great that interference with already established natural protective barriers was considered inadvisable. Gunshot and stab wounds of the abdomen in which penetration of the abdomen was suspected, but not found when exploratory

* Read before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

celiotomy was performed, are not included in this report. Figure 1 shows, graphically, the incidence of the injuries according to race, sex, and age.

The weapon with which the gunshot wounds were inflicted was most frequently a pistol, usually of .32 or .38 caliber, but in several instances the weapons were of .44 or .45 caliber. Three wounds were caused by rifle bullets, which, in two instances, were of .22 caliber. In two instances, the wounds were produced by shotgun fire. In all of the stab wound cases, the injuries were inflicted with a knife, except in one instance in which the wound was produced by a stalk of sugar cane, which accidentally penetrated the peritoneal cavity after passing through the anus. In the gunshot cases, even the approximate distance between the injured person and the firearm frequently could not be accurately determined, but varied from immediate contact to usually not more than 20 feet. Because of the confusion ordinarily existing at the time when such injuries are incurred, accurate data concerning the position of the injured person in relation to the weapon usually could not be obtained. Details of this latter sort, as well as accurate information concerning the position or physical attitude (*i.e.*, erect, bending over, crouched), of the patient are of value, and, as observed by Meyer and Shapiro,[38] account for the bizarre courses of projectiles, often erroneously ascribed to deflection or ricocheting of bullets.

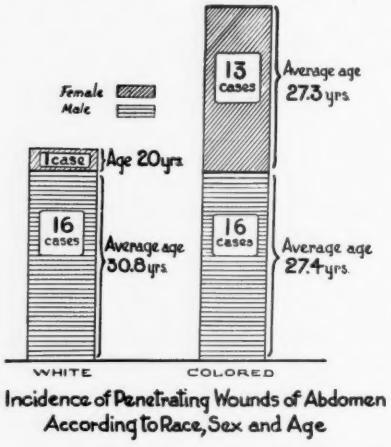


FIG. 1.—Graphic representation showing the incidence of penetrating wounds of the abdomen, according to race, sex, and age.

Most of the gunshot injuries resulted from a single projectile, as was definitely recorded in 29 cases; in two instances, two projectiles entered the abdomen. There were multiple wounds of the abdomen in two cases in which the injuries were inflicted by a shotgun. In the ten stab wound cases in which the number of penetrations was recorded, the patient had been stabbed only once. In ten gunshot cases, there was a single wound of exit; in two cases, there were two wounds of exit; and in the remaining cases, there were no wounds of exit. In none of the stab wound cases was there a wound of exit.

Eighteen of the patients were brought to the hospital by ambulance. One of the fatal gunshot wound cases drove himself to the hospital, the trip requiring three hours. Another patient, in the gunshot wound group, walked three blocks to the hospital. The other cases, with the exception of one fatal case who was transported by police patrol, were brought to the hospital by ordinary passenger automobiles. Transportation of patients with penetrating wounds of the abdomen in properly heated ambulances is obviously the ideal method of transferring such patients unless alarming hemorrhage

makes undesirable the delay which would be involved in summoning the ambulance.

The average period elapsed from the time of injury to the time of admission to the hospital for the combined gunshot and stab wound groups was 131.8 minutes; the average period in the survival cases was 140 minutes, whereas in the fatal cases the period was 117 minutes. The longer average duration in the survival cases was due to the transportation over long distances of several patients who were in very good condition. The period elapsed from time of admission until time of operation, which time was required for observation, treatment of shock, or other preparation for operation, was 83.8 minutes; the average period for the survival cases being 65 minutes, whereas, in the instance of the fatal cases, the period was 116 minutes. The average duration from time of injury until time of operation, for the combined gunshot and stab wound cases, was 215.6 minutes; in the survival cases this interval averaged 205 minutes, whereas in the fatal group it was 233 minutes.

Preoperative Symptoms.—Abdominal pain was present in many cases, but, frequently, this symptom was remarkably indefinite or practically absent; the pain due to associated injuries was often greater than the abdominal pain. Acute alcoholism in eight cases, seven of which were gunshot wound cases, might have obtunded sensation, but the absence of considerable abdominal pain was repeatedly observed in the instances of patients who had not been drinking. The presence or absence of abdominal pain, certainly, cannot be relied upon as evidence that penetration of the abdominal cavity has or has not occurred. The indications of peritoneal irritation, including abdominal pain, were almost always directly proportional to the amount of blood in the peritoneal cavity or to the amount of spillage from the stomach, small intestine, or gallbladder. Abdominal pain was remarkably absent in the cases with perforations of the large intestine, probably because of the small amount of spillage of solid or semisolid fecal material. Abdominal pain is particularly likely to be absent in gunshot wound cases in which the bullet enters the peritoneal cavity through the gluteal, sacral, or perineal regions, and penetration of the peritoneum is frequently overlooked in such cases. In no instance was it noted that pain was referred to the base of the neck or to the scapular region, even though the amount of blood present in the peritoneal cavity in many instances might have been expected to cause such referred pain.

In several cases, in which there had been massive hemorrhage, the patients experienced air hunger and extreme thirst. Nausea and vomiting were recorded in only three cases, and in no instance was there a record of hematemesis, even though the stomach was perforated in several cases.

Preoperative Physical Findings.—The average temperature in the combined groups was 99.2° F., without any considerable difference in the averages for the survival or the fatal cases, although instances of subnormal temperatures were more frequently noted among the fatal cases. The respiratory

rate averaged 25 per minute, without any considerable difference in respect either to range or average in the survival or the fatal cases; the pulse rate for the combined groups averaged 109 per minute, with an average of five pulsations more per minute in the fatal group, and with no considerable difference in the range; *i.e.*, 66 to 135 and 68 to 140, in the survival and the fatal groups, respectively.

Blood pressures for the combined groups averaged 107/65 Mm. Hg., the average in the survival group being 120/67 and in the fatal group 90/62. The range of blood pressures in the survival group was 180/90 to 92/60, while the range in the fatal group was 112/80 to 58/40.

In the combined gunshot and stab wound cases which lived, shock was recorded as slight in two cases, as moderate in one case, and of an unspecified degree in six cases, whereas in the group which died the degree of shock was recorded as moderate in two instances, marked in two instances, and of unspecified degree in five instances.

Abdominal tenderness was recorded in only nine instances in the combined gunshot and stab wound groups, eight of which were gunshot cases. Abdominal rigidity was recorded in 11 cases; only one of the cases in which rigidity was recorded was a stab wound case. The relatively low incidence of recorded tenderness and rigidity was probably due, at least in part, to failure to record these conditions.

Rectal examination revealed varying degrees of tenderness. In the case in which the penetrating wound was produced by a stalk of sugar cane entering the rectum, as well as in some cases of gunshot wounds involving the rectum, rectal examination revealed blood, and in several instances, the perforation could be felt. Vaginal examination in one case revealed distinct tenderness in the fornices.

Abdominal distention was present to a moderate degree at the time of admission in one case. Absence of liver dulness was not recorded in any case in either group, although repeated attempts were made to elicit this evidence of gas or air in the peritoneal cavity. A completely thoracic type of breathing was observed in only one instance, a gunshot wound case with associated spinal cord injury, but respiration with practically no abdominal component was present in several additional cases.

Clinical Laboratory Findings.—Examination of the urine for gross or microscopic blood was made in all cases. Hematuria was present to some degree in 15 instances. In seven cases, in which blood was detected microscopically, the red blood cells were reported as few in one instance, many in one instance, and the number was unspecified in five instances. Gross hematuria was observed in three cases. In five cases it was not noted whether the blood was detected grossly or microscopically. A positive Wassermann reaction was obtained in eight cases in the combined groups. Red blood cell counts and hemoglobin index determinations were made in only a few cases, because such examinations are usually of practically no value in determining the management of patients with penetrating wounds of the abdomen. Signifi-

cant lowering of the red blood cell counts and hemoglobin index in the presence of slow and moderate hemorrhage, as well as in sudden massive hemorrhage, is almost invariably preceded by clinical evidences of hemorrhage and shock. Whenever doubt exists concerning the degree or continuance of bleeding, exploratory celiotomy is usually a safer procedure than is prolonged observation of the patient for changes in the red blood cell count or hemoglobin index.

Plasma protein determinations, although not likely to be of particular value in the preoperative estimation of patients with penetrating wounds of the abdomen, may serve as an important therapeutic guide in the postoperative management of such cases. Several methods are now available for rapid estimation of plasma protein levels, including the falling-drop method[48] and the Bing-bead method.[49]

Roentgenologic Findings.—Fluoroscopic or skiagraphic examinations were undertaken in most of the gunshot wound cases. These examinations were made not only to locate bullets but were also made to determine the presence of such conditions as hemopneumothorax and fractures of the extremities. In no instance was the presence of air or gas beneath the diaphragm demonstrated roentgenographically. Exact localization of bullets by one of the several methods available may, at times, be of distinct value in the management of bullet wounds of the abdomen, and exact localization of bullets by the Granger[47] method was undertaken in several cases in this series.

Associated Conditions.—Associated chest injuries were recorded in a total of 11 cases in the combined groups. Two of the gunshot wounds, with associated chest injuries, had an extensive hemopneumothorax. One of the gunshot wound cases, who was five months pregnant, had a penetration of the gastrohepatic omentum and a moderate degree of intraperitoneal hemorrhage; this patient was subsequently delivered of a normal child, without any complications during parturition. Spinal cord injury existed in two gunshot wound cases, and in each instance was manifested by paralysis of the lower extremities which was present at the time of admission. In several cases, there were associated injuries of the head, the neck, or the extremities.

Choice of Cases for Operation and Time of Operation.—The preoperative determination of whether or not penetration of the peritoneal cavity has occurred is often difficult, and the fallacy of depending on such factors as the presence or absence of abdominal pain, tenderness, or rigidity to determine whether or not penetration of the abdomen has occurred, has already been referred to. Eisberg[50] also has observed the inconstancy of the signs and symptoms present in penetrating wounds of the abdomen and, in accordance with Schoenberg,[51] Silleck,[52] and Winslow,[53] he advocates exploratory celiotomy in all doubtful cases. Although it has been contended that penetrating wounds of the abdomen caused by small-sized birdshot do not require exploratory celiotomy, the serious hemorrhage due to injury of important blood vessels, as well as the possible production of gaping lacerated wounds of the intestinal wall which may be produced by such small-sized shot, makes the nonoperative treatment of even such injuries inadvisable.

Eisberg[50] stresses the importance of the study of the entrance and exit points, and he cites that bullet wounds of entrance are usually smaller than the caliber of the bullet, while the point of exit is more or less keyhole in shape and larger than the wound of entrance. He also draws attention to the fact that "if an area of abrasion and contusion is concentric, it signifies that the bullet has taken a straight course, and that the underlying viscera in this region are, in all probability, injured; if the area is to the right of the edge of the wound, it signifies that the missile has passed from right to left. Since the opposite side of this area is always undermined, and this process, in turn, in-

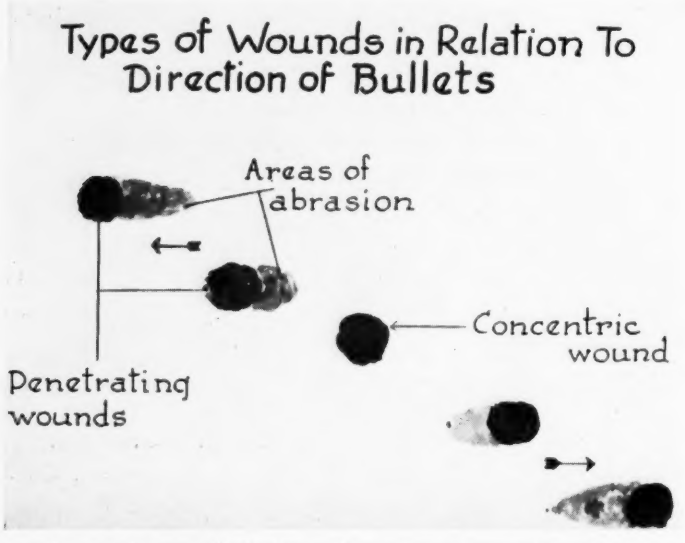
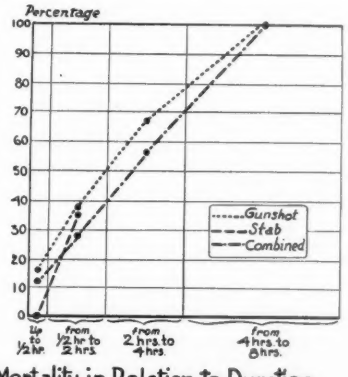


FIG. 2.—Drawing illustrating various types of external wounds in relation to the courses taken by bullets. A concentric area of abrasion and contusion indicates that the bullet has taken a straight course. If the area of abrasion is to the right of the edge of the wound, it signifies that the missile has passed from right to left, and *vice versa* if the area of abrasion is to the left of the edge of the wound. Furthermore, the amount of undermining beneath the edge of the wound opposite the area of abrasion may indicate the obliquity of the course of the missile.

creases with the obliquity, the more superficial the bullet tract the larger the area of abrasion and contusion and the greater the undermining as shown in Figure 2. This observation is very important in differentiating superficial nonpenetrating wounds of the abdomen which cross the abdomen causing pain and at times nausea, vomiting, tenderness and rigidity." Davis,[54] although observing that rigidity, localized pain, and tenderness on pressure are common symptoms, and that pain is greater, and rigidity usually board-like, when the stomach or intestines are perforated, says that these findings are not always dependable. In the instance of gunshot wounds when the bullet has not made its exit, study of the roentgenographically localized bullet in relation to the wound of entrance is usually of obvious value. Even when it seems unlikely that penetration of the abdominal cavity has occurred, the possibility of the bullet having ricocheted after penetrating the skin and subcutaneous tissue as well as the effect of the position of the patient or the influence of respira-

ory movement on the course of the bullet, as pointed out by Meyer and Shapiro,[38] must be kept in mind. Unexpected and unpredictable visceral injuries were found in several cases in the present series.

It was often difficult to determine the optimal time for operation, and, although it was frequently impossible to improve the patient's condition to the desired degree before operation, celiotomy was performed as soon as the patient's condition was sufficiently good to permit abdominal exploration. Oberhelman and LeCount,[55] on the basis of a review of the literature and a study of 343 cases treated at the Cook County Hospital, expressed the belief that "perhaps the most important element aiding the recovery of patients with bullet wounds of the abdomen is a short interval between the injury and the operation." Realizing the irreversible deleterious effects produced by prolonged shock, and recognizing the importance of rapid preparation for operation of patients with penetrating wounds of the abdomen, as emphasized by Condict,[56] and at the same time appreciating the advisability of avoiding operation in the presence of profound or even considerable shock, rapid preparation of the patients for operation was attempted in all cases. However, the intentional delay of operation for several hours seemed advisable in several instances. When there was no evidence of considerable shock, operations were undertaken promptly, to avert the possible development of shock from continued slight bleeding or subsequent massive hemorrhage.



Mortality in Relation to Duration from Time of Admission to Operation

CHART 1.—Curve indicating the mortality in relation to the period elapsed from the time of admission to the hospital to the time of operation. The form of this curve is, in part, due to the good condition of those patients upon whom early operation could be performed without considerable preoperative preparation.

The decision concerning the advisability of operation in cases of relatively long duration is frequently difficult. Although it is impossible, on the basis of elapsed time alone, to arbitrarily fix a late time limit for operability, natural protective barriers such as fibrinous exudate and adhesions, as well as the edema which often results in the sealing off or closure of hollow visceral injuries, have usually become well established within 12 or 14 hours following injury. In the instance of penetrating wounds involving only the upper abdomen, the period during which operation is advisable may be considerably extended because, in upper abdominal injuries, not only is continued hemorrhage from the liver or spleen likely to make even late operation necessary, but the absence of, or smaller number of perforations of hollow viscera in such cases makes late operation relatively safe.

The consistent direct relationship between the mortality and the duration from time of hospital admission to operation (Chart 1) not only emphasizes the advisability of performing celiotomy as soon as the patient's condition per-

mits, but the form of this curve is actually the result of the relatively good condition of the patient upon whom early operation was performed. The higher mortality rate in the instance of cases in which there was a long period between the time of admission and operation was not due to the prolongation of this period either by choice, or through neglect to expedite preoperative preparation or to perform early operation, but was due to the fact that the poor condition of these patients necessitated prolonged preoperative preparation in an attempt to prepare them to withstand operative intervention.

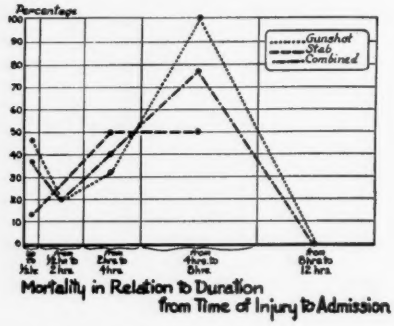


CHART 2.—Curve showing the mortality in relation to the period of time elapsed from the time of injury to the time of admission. The forms of the curves reflect the influence of shock and hemorrhage and emphasize the value of the early institution of measures to combat these conditions. The comparatively low mortality in the cases admitted to the hospital from one-half to two hours following injury suggests that patients in this group were either suffering from a less severe degree of shock and hemorrhage, or that considerable recovery from these conditions had occurred before celiotomy was performed. The higher mortality in the group of cases who were admitted to the hospital within half an hour following their injury, although partly due to the seriousness of the injury or to primarily severe shock and hemorrhage, was probably to some extent the result of the performance of celiotomy at a time when some of the patients in this group were still suffering from shock or hemorrhage. The recovery of all patients whose admission to the hospital was delayed for from eight to 12 hours is presumably due to the fact that these patients did not have extremely serious injuries; that they were not suffering from massive hemorrhage; and that they had either never suffered from or had recovered from shock. The high mortality in the group of patients admitted within four to eight hours following their injury may be considered to be the result of the deleterious effect of prolonged shock and arterial hypotension.

Chart 2 graphically indicates the influence of shock and hemorrhage upon the mortality in penetrating wounds of the abdomen. The comparatively low mortality in the cases admitted to the hospital from one-half hour to two hours following injury suggests that patients in this group were either suffering from a less severe degree of shock and hemorrhage, or that considerable recovery from these conditions had occurred before celiotomy was performed. The higher mortality in the group of cases who were admitted to the hospital within half an hour following their injury, although probably partly due to the seriousness of the injuries or to primarily severe shock and hemorrhage, was probably to some extent the result of the performance of celiotomy at a time when some of the patients in this group were still suffering from considerable shock or hemorrhage. The recovery of all patients whose admission to the hospital was delayed for from eight to 12 hours is evidently due to the fact that these patients did not have extremely serious injuries, that they were not suffering from massive hemorrhage, and that they had either never suffered from or had recovered from shock. The high mortality in the group of patients admitted to the hospital within four to eight hours following their injury may be considered to be the result of the deleterious effect of prolonged shock and arterial hypotension.

Preoperative Preparation, Including Preanesthetic Preparation.—When patients were first seen, measures to combat shock were instituted immediately. In addition to the application of external heat and elevation of the foot of the bed, morphine sulphate was administered in appropriate large doses.

In the instance of patients who were considerably intoxicated at the time of admission, oxygen was administered by inhalation, and was usually effective in considerably sobering these individuals.

The importance of sometimes administering preoperative transfusions of as much as 2,000 to 3,000 cc. of blood within the first 24 hours following penetrating injury of the abdomen, the difficulties of obtaining blood for this class of cases, and the improved methods now available for storing blood, have been discussed in a previous communication,[19] which included a consideration of various methods of transfusion, and indicated the dangers of autotransfusion of blood obtained from the abdominal or thoracic cavities. The relationship between the degree of hemorrhage and the mortality in the present gunshot wound cases, as shown in Figure 3, has also been referred to by Mason,[12, 13] Loria,[23] and others; and in addition emphasizing the importance of adequate preoperative transfusion, indicates the advisability of first directing attention during operation to the detection of bleeding points and the arrest of hemorrhage.

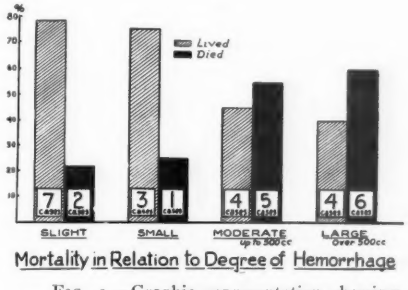


FIG. 3.—Graphic representation showing the direct relationship between the degree of hemorrhage and the mortality. Comparison of Figure 3 with Figure 4, which latter figure shows the average number of visceral perforations in relationship to mortality, reveals how much more important is the relationship between hemorrhage and mortality than is the relationship between the number of perforations and mortality.

Eleven patients were given fluids by infusions or hypodermoclyses, which usually consisted of 1,000 cc. of 5 to 10 per cent glucose, and normal to 2 per cent saline solution, or lactated Ringer's solution. When glucose solution of more than 5 per cent is employed, it is considered advisable to counteract the peristaltic inhibiting effect of such solutions by the administration of appropriate amounts of insulin, as suggested by the observations of Ochsner, *et al.*[57] In general, the administration of fluids in the form of blood transfusions rather than infusions is particularly desirable in those cases in which continuing hemorrhage is evident or suspected.

A 3,000 unit prophylactic dose of antitetanic serum was given to all gunshot cases, and at least 1,500 units were given to all stab wound cases. Mixed antianaerobic serum was administered to three of the gunshot wound cases, and one of the gunshot wound patients received perfringens antitoxin.

Stimulant drugs, including caffeine sodium benzoate and adrenalin, were administered preoperatively to six cases. All of the patients to whom it was considered necessary to administer stimulants preoperatively, died. Although there may be occasional indication for the use of so-called stimulant drugs, benefit is more likely to follow the infusion of solutions of sodium chloride, glucose, or acacia; blood transfusion; or the placing of the patient in the head-down position.

Preoperative catheterization was performed when patients were unable to void, both for the purpose of obtaining a specimen of urine for examination

and of being assured that the bladder would be empty at operation. In three instances of injury involving the urinary tract, preoperative cystoscopy and introduction of ureteral catheters was done.

In order that operation might be started as soon as shock was sufficiently combated, some of the patients were immediately sent to the operating room for preoperative observation and preparation, thereby avoiding moving of the patients on and off carriers and in and out of bed.

The respiratory stimulating effect of scopolamine, referred to by Waters,[58] suggests that this drug, rather than atropine, should be employed for preanesthetic preparation purposes.

TABLE I
MORTALITY IN RELATION TO ANESTHESIA

	ETHER	ETHYLENE	SPINAL & ETHYLENE	SPINAL & ETHER	SPINAL	LOCAL	LOCAL & ETHER
GUNSHOT							
Lived	10	2	1	1	6	0	1
Died	13	0	0	0	0	1	0
STAB							
Lived	1	1	0	0	4	2	0
Died	1	1	0	0	0	1	0
COMBINED							
Lived	11	3	1	1	10	2	1
Died	14	1	0	0	0	2	0

Table I shows the mortality in relationship to the type of anesthesia. The absence of any deaths when spinal anesthesia was employed, either alone or in combination with ethylene or ether, is remarkable even though the cases in which spinal anesthesia was employed were those in which there was not a pronounced preoperative depression of the blood pressures. The high mortality when either ether or local anesthesia was used was due to the practice of employing these anesthetics for those patients who manifested the greater degrees of shock and hemorrhage.

Anesthesia.—The choice of the anesthetic was, in each case, based upon the patient's preoperative condition, the presence or absence of chest or other extra-abdominal injury, and the extent of operative procedures estimated to be necessary. The frequency with which various types of anesthetics were employed and the mortality according to the anesthetics used are shown in Table I. The absence of any deaths when spinal anesthesia was employed, either alone or in combination with ethylene or ether, is remarkable, even though the cases in which spinal anesthesia was employed were those in which there was not a pronounced preoperative depression of the blood pressures. The higher mortality when either ether or local anesthesia was employed was unquestionably due to the practice of employing these anesthetics for those patients who manifested the greater degrees of shock and hemorrhage. The relatively high concentration of oxygen which may be maintained in the anesthetic mixture when cyclopropane is employed as an anesthetic agent makes this form of gas anesthesia particularly desirable in some cases of penetrating wounds of the abdomen.

Attention to the Patient on the Operating Table, Aside from the Principal Operative Procedure.—Despite the preoperative institution of measures to combat shock, some degree of shock was frequently still present when the operation was begun, so that the continuation of shock therapy was sometimes necessary or had to be instituted in the operating room. Frequent determinations of the pulse rate and the blood pressure were made during the patient's stay in the operating room, both for the purpose of serving as a guide to the administration of fluids or stimulants, and because of the value of these determinations in indicating permissible operative procedure. The upper end of the operating table was sometimes kept lowered as much as 30° during the operation.

Type of Incision.—The type of incision varied greatly, being determined by such factors as the site of the wound of entry, the location of the wound of exit, or the position of bullets which could be felt or detected either roentgenographically or by fluoroscopic examination. Rectus abdominis muscle-splitting incisions were most frequently employed in order to save time in entering the abdomen and to minimize the amount of separation of the rectus abdominis muscle from its sheath.

Findings at Operation.—As previously indicated, the ricochet of bullets and the displacement of viscera by respiration, as well as variations in the relative position of parts of the patient's body as compared with the position of the same parts on the operating table, accounted for unexpected and unpredictable visceral injuries in several instances. The opening of the peritoneal cavity was never accompanied by the hissing sound sometimes heard in cases of perforated peptic ulcer in which there is considerable gas in the abdominal cavity. The failure to find gas under pressure in the peritoneal cavity at the time of operation might have been due to the previous escape of gas through abdominal wall perforations.

The quantity of either liquid or clotted blood in the peritoneal cavity varied greatly. Accurate determination of these amounts was practically impossible because, in addition to the volume collected in suction apparatus jars, at least some of the blood was always removed in the form of clots or by means of sponges. When the hemorrhage was massive, liquid blood sometimes poured out of the wound before it could be collected and measured.

Extraperitoneal hemorrhage was found in a number of the gunshot wound cases, and was perivesical in one case; retrovesical and perinephritic in one case; retroperitoneal in four cases; retrosigmoid in three cases; perirenal in two cases; and of unspecified location in one case. In the 12 cases in which there was some type of extraperitoneal hemorrhage, there were seven survivals and five fatalities. Estimates of the amount of extraperitoneal hemorrhage are likely to be very inaccurate, and such estimates were not attempted.

Bullets lodged in the subcutaneous tissue or superficially situated in muscle tissue were removed at the time of operation in four cases. In one instance, a bullet was found lying free in Morrison's pouch. Bullets which were not readily located or easily removable at the time of operation were usually removed several days later, under local anesthesia.

Spillage of a considerable amount of intestinal contents was recorded in only six cases, all of which were gunshot wound cases which survived. This apparent paradox is evidently due to the fact that in every case in which considerable spillage was recognizable, the amount of hemorrhage was slight, thereby permitting recognition of the spillage as well as favoring recovery.

The total number of perforations of either solid or hollow viscera was only slightly less in the group which lived than in the group which died. In the survival cases there was an average of 5.33 perforations per patient, with a maximum of 25 perforations in a single case, whereas in the fatal cases

there was an average of 5.71 perforations per patient, with a maximum of 18 perforations in a single case. The lack of a distinct relationship between the number of perforations and the mortality (Fig. 4) is noteworthy, in contrast with the close relationship existing between the amount of hemorrhage and the mortality (Fig. 3).

Stomach perforation occurred in six cases. In four instances, the stomach injuries were the result of gunshot wounds and were in each instance associated with injury of other viscera. In two instances, the stomach injury resulting from gunshot wounds was associated with injury of the liver. As previously mentioned, there was no record of hematemesis in any case. In one instance, two stomach perforations were associated with perforations of the jejunum. In another gunshot case, a stomach perforation was associated with perforation of the transverse colon as well as the jejunum. In the stab wound cases, stomach injury occurred in two instances. In one of these latter cases there was associated evisceration of the stomach. The other patient had two perforations of the stomach. Whenever wounds involving the anterior wall of the stomach were found, the lesser peritoneal cavity was entered and the posterior surface of the stomach was examined for the wound which is to be anticipated in that region, particularly in the instance of gunshot wounds. Instead of dividing the gastrocolic or gastrohepatic omenta for the purpose of revealing or permitting repair of wounds on the posterior wall of the stomach, satisfactory exposure and repair may be accomplished by enlarging the wound located in the anterior stomach wall, as suggested by Prey and Foster.[59]

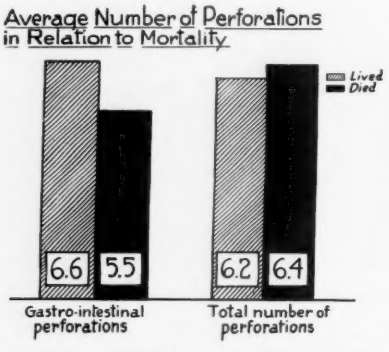


FIG. 4.—Graphic representation showing the average number of visceral perforations in relationship to the mortality. Comparison of this figure with Figure 3 reveals the fact that the degree of hemorrhage is more directly related to the mortality in penetrating wounds of the abdomen than is the number of perforations.

Duodenal injury was not found in any case in this series. Because injuries to the duodenum may be easily overlooked, and because of the importance of accurate closure of such injuries, thorough search for duodenal wounds was made, especially when injuries were located in the upper abdomen.

Injury to the jejunum was specifically recorded in seven gunshot wound cases, and in all but one of these patients there were associated injuries of other viscera, thus probably accounting for the survival of only four of these individuals. The patient in which there was jejunal injury alone, lived. The jejunum was eviscerated in two stab wound cases and in one instance there was an associated incised wound of the jejunum; the former patient lived and the latter died. Although a favorable prognosis might be expected because of the character of the bacterial flora of the jejunum, a relatively high mortality, such as occurred in the present cases, has been reported by others.

Injuries of the ileum were specifically recorded in 12 gunshot wound cases, with eight survivals and four fatalities. In one stab wound case, perforation of the ileum was associated with partial evisceration of the ileum; this case survived. This relatively high survival rate among patients with injury of the ileum is particularly remarkable since in all but one instance the injuries to the ileum were associated with injury of one or more other viscera, such as the colon, cecum, rectum, jejunum, ureter, uterus, or bladder.

Perforation of the cecum occurred in four of the gunshot wound cases, all of which lived. Except for the fact that there was a relatively small amount of hemorrhage in three of these cases, the absence of any mortality accompanying injuries to the cecum would be especially surprising, since in three instances there were associated perforations of the ileum and in one instance perforation of the rectum. In no case in this series was there injury to the appendix, although in one of the gunshot wound cases there was injury to the mesoappendix, which necessitated appendicectomy.

The ascending colon was injured in one gunshot wound case and this patient lived, although his convalescence was prolonged by the development of an extensive abdominal wall infection. Transverse colon perforation occurred only once; this patient, who had associated stomach and jejunal perforations, died. The transverse colon was eviscerated in two of the stab wound cases, but in neither instance was it perforated; both these patients lived. The descending colon was injured in the region of the splenic flexure in one gunshot wound case in which there was also considerable retroperitoneal hemorrhage; this patient died. The sigmoid colon was injured in five cases. One patient, with a perforation of the sigmoid and associated lacerated perforations of the jejunum, lived; two patients with perforations of the sigmoid and two patients with contusions of the sigmoid died. The four latter sigmoid injuries were associated either with small bowel or liver penetrations, or with considerable hemorrhage.

The rectum was perforated in four cases. Three of these injuries were gunshot wounds, and two of the patients lived, whereas one died. In all of the gunshot wound injuries of the rectum, the bullet entered through the buttocks. When the wound of entry is so located, the possibility of intraperitoneal injury is frequently overlooked and the intraperitoneal entrance of the bullet may not be recognized until signs of localized or diffuse peritonitis become apparent. It has even happened that patients with gunshot wounds of the buttocks have been discharged from the hospital before intraperitoneal injury was recognized, only to be rehospitalized several days later when definite evidence of peritonitis had developed. The other case in this series in which perforation of the rectum occurred, was one in which a stalk of sugar cane accidentally entered the anus, and caused perforation of the anal canal, the rectum, and the neck of the bladder; this patient survived.

The relatively low mortality rate in the group of cases with large intestine injury was strikingly at variance with the generally conceded seriousness of large intestine injuries, and was probably due to the relatively small quantity

of spillage which ordinarily accompanies such injuries, as well as to the tendency of the relatively solid large intestine content which does escape, to remain localized.

Perforation of the gallbladder in the region of its neck occurred in one gunshot wound case, while in another gunshot wound case there was injury of the common bile duct associated with injury to the pancreas, jejunal mesentery, and spinal cord; both of these patients died.

Injuries to the ureter, kidney, bladder or prostate occurred in ten instances. In most of the cases with urinary tract injury, the existence of the lesion was suspected because of the location or direction of the gunshot or stab wounds. In several instances, however, unsuspected urinary tract injuries were revealed as a result of routine examination of the urine for gross or microscopic blood. The kidney was injured in three cases in the gunshot wound group; in two instances the injuries were located in the upper pole of the kidney, and were followed by survival in one instance and death in the other; the third case had an injury of the kidney in the hilar region, and this patient died. Injury to the kidney occurred in one stab wound case; this patient lived. Kidney injuries are particularly serious, and there is no efficient method of dealing with them. The retroperitoneal location of the kidneys, and the large retroperitoneal hematomata, usually associated with injuries to the kidneys, frequently make it impossible to accurately determine the location and extent of the injury. Under such circumstances, exposure of the renal blood vessels is extremely difficult, and either transperitoneal nephrectomy, after mobilizing the mesocolon, or removal of the kidney through a separate lumbar incision involves dangerous additional trauma and prolongation of the operation. Injury of the left ureter was present in one of the gunshot wound cases and was associated with moderate retroperitoneal hemorrhage extending between the leaves of the descending colon and sigmoid mesenteries; this patient lived.

Injury to the bladder occurred in five cases in the gunshot wound group. In two instances, these injuries were contusions or incompletely penetrating injuries of the bladder wall; both of these cases, in one of which there was considerable perivesical hemorrhage, survived following plication of the bladder wall. One case in which perforation of the bladder was associated with perforation of the prostate survived. Of the remaining two gunshot wounds of the bladder, both of which were perforating wounds, one was accompanied by considerable extravasation of urine; both of the latter cases died. In one of the stab wound cases, perforation of the vesical neck was associated with perforation of both the prostate and the rectum; this patient survived.

Perforation of the uterus occurred in one gunshot case and was associated with hemorrhage into the broad ligament. This patient lived following closure of the uterine perforation and ligation of bleeding points in the broad ligament.

The diaphragm was injured in one stab wound case, in which there was associated chest perforation caused by the same stab wound. In this case, the twelfth rib was resected and, following peritoneal exploration through

the opening in the diaphragm, transpleural repair of the diaphragm was effected; the patient lived. In none of the gunshot wound cases was the diaphragm injured.

Injury of the liver occurred in nine cases, and was the result of a gunshot wound in every instance. In six cases, the injuries of the liver were accompanied by injuries to other important viscera; five of these patients lived while four died. In seven cases, the injury was limited to the right lobe; in one instance, there was injury of both the right and the left lobes; in the remaining case, the site of the liver injury was not recorded. In five instances, the character of the wound was stellate or lacerated, and in one instance a furrowed wound involved the lower surface of the right and left lobes; the rest of the wounds were punctate. In the nine gunshot wound cases in which injury to the liver occurred, there were, in three instances, no associated lesions, and of these patients, two lived and one died, while in the six cases with associated injuries to other viscera there were three deaths and three survivals. Blood clots which had formed between liver lacerations were usually not disturbed because of the bleeding which usually follows their removal. In none of the stab wound cases was the liver injured.

Spleen injuries occurred in three gunshot wound cases, but injury to this organ was not observed in any of the stab wound cases. In one instance, the perforation was located in the upper half of the spleen while in two instances the injury occurred through the lower pole; two of these patients lived. In the fatal case, a punctate wound involved the lower pole of the spleen. A moderate to a large amount of hemorrhage was associated with the injuries to the spleen. Two of the three cases lived without splenectomy being performed. The third case had an accompanying kidney perforation which may have played an important part in causing death. It is probably usually advisable to perform splenectomy, if the injury of the spleen is a lacerated one or if it is located near the hilum of the spleen. However, if the patient's condition is extremely poor, if there are many associated hollow visceral injuries, if the spleen wound is punctate and located away from the hilum, and if no bleeding from the spleen is occurring at the time of operation, it is sometimes better not to perform splenectomy.

The pancreas was injured in only one case. This injury, which occurred in the region of the head of the pancreas, was associated with injury of the spinal cord, the common bile duct, and the jejunal mesentery. Death occurred several days following exploration and the introduction of drains which extended down to the site of the injury to the pancreas and the bile ducts. The outcome following a gunshot injury of the pancreas is largely dependent upon whether or not one or both of the principal pancreatic ducts have been injured, and upon the character of the associated injuries. Transplantation of the pancreas or the pancreatic ducts into the small intestine is usually not feasible in the instance of patients who have penetrating wounds of the abdomen.

TABLE II

GUNSHOT WOUNDS

SHOWING THE SEX, AGE, COLOR, NUMBER AND SITE OF EXTERNAL WOUNDS, DURATION FROM TIME OF INJURY UNTIL OPERATION, ASSOCIATED INJURIES AND OTHER FINDINGS, SYMPTOMS AND PHYSICAL FINDINGS, FINDINGS AT OPERATION, OPERATIVE PROCEDURE, AND THE OUTCOME OF THE CASES IN THE PRESENT SERIES

Initials and Case No.	Sex	Age	Color	Number and Site of External Wounds	Duration from Time of Injury until Operation	Associated Injuries and Other Findings	Symptoms and Physical Findings	Findings at Operation	Procedure	Result
M. B. 1	M.	25	C.	1 (entrance) below and to right of umbilicus	2 hrs. 30 mins.	Contusion of scalp. Positive Wassermann	Nausea, B.P. 128/70, P. 90, T. 100, R. 26. Abdominal rigidity	Contusion of bladder; 3 perforations of ileum; perivesical hematoma	Ileorrhaphies (3); plication of bladder	L.
A. B. 2	M.	38	W.	1 (entrance) lower anterior chest	3 hrs. 20 mins.	Gunshot wound of chest with hemopneumothorax	B.P. 130/70, P. 116, T. 99.5, R. 22. Moderate shock. Abdominal rigidity	Lacerated wound of dome of liver; old omental adhesions; moderate amount of hemorrhage	Exploration; evacuation of liquid blood and clots; division of omental adhesions	L.
Q. B. 3	M.	11	W.	1 (entrance) below left anterior costal border. 1 (exit) below and to right of umbilicus	4 hrs. 30 mins.		P. 126, R. 28. Slight shock. Abdominal rigidity	22 perforations of jejunum and ileum and 3 of small intestinal mesentery; moderate amount of hemorrhage	Enterorrhaphies (22)	L.
T. C. 4	M.	37	W.	1 (entrance) right upper quadrant	50 mins.			One perforation of ascending colon; slight amount of hemorrhage	Colorrhaphy (1)	L.
C D. 5	M.	21	W.	1 (entrance) below left costal margin	1 hr. 35 mins.		B.P. 130/80, P. 135. Abdominal tenderness and rigidity	Retroperitoneal hemorrhage; one perforation of descending mesocolon; 2 perforations of stomach; 2 of jejunum (1 lacerated); small amount of hemorrhage	Gastrorrhaphies (2); suture of mesocolon; jejunorrhaphies (2)	L.
F D. 6	M.	13	W.	1 (entrance) right eighth midaxillary. 1 (exit) to left of midline 2 inches below xiphoid	1 hr. 30 mins.	Perforation of right chest; superficial wound of right arm	B.P. 92/60, P. 96, R. 22. Shock	Penetrating wound of upper posterolateral portion of liver; large amount of hemorrhage	Exploration; removal of clots and liquid blood introduction of pack	L.

E. F. 7	F.	21	C.	1 (entrance) 2 inches below lower right costal margin in midclavicular line	12 hrs. 40 mins.	Compound gunshot fracture of left finger	Very slight shock. Abdominal tenderness and rigidity	Furrowing wound inferior surface right and left lobes of liver; perforation of upper half of spleen and gastrohepatic meso; slight hemorrhage	Exploration; suture of gastrohepatic omentum; débridement of hand	L.
J. G. 8	M.		C.	1 (entrance) left tenth interspace in anterior axillary line	4 hrs. 20 mins.	Abrasion of left upper eyelid	B.P. 130/70, P. 66, R. 22. Shock	Perforation of lower pole of spleen; slight amount of hemorrhage	Exploration; removal of liquid blood and blood clots	L.
R. H. 9	M.	26	C.	1 (entrance) ½ inch medial to left anterior superior iliac spine	70 mins		B.P. 95/60	11 perforations of ileum; 1 lacerated wound of cecum; slight amount of hemorrhage	Ileorrhaphies (11); typhlorrhaphy (1); appendicectomy; cecostomy; removal of bullet	L.
E. J. 10	F.	26	C.	1 (entrance) left upper abdomen	60 mins.		Slight abdominal tenderness	10 perforations of ileum; 1 perforation of cecum	Ileorrhaphies (10); typhlorrhaphy (1)	L.
E. J. 11	F.	20	C.	1 (entrance) upper left buttock	45 mins.		B.P. 108/70. Abdominal tenderness and rigidity	Rupture of perivesical veins; 7 perforations of ileum; contusion of bladder; slight amount of hemorrhage	Ileorrhaphies (7); ligation of perivesical veins; appendicectomy; cecostomy	L.
V. J. 12	F.	22	C.	1 (entrance) right anterior costal border and 1 (exit) right lumbar	55 mins.	Positive Wassermann	Shock	Perinephritic hematoma; perforation of right upper pole of kidney; stellate laceration lower right lobe of liver; large amount of hemorrhage	Hepatorrhaphy (1); introduction of packs	L.
W. J. 13	M.	23	C.	1 (entrance) right buttock	60 mins.			Perforation of rectum and bladder	Proctorrhaphy (1); cystorrhaphy (1); suprapubic cystotomy	L.
J. T. 14	M.	22	C.	1 (entrance) buttock with 1 (exit) to left and below umbilicus	3 hrs.	Positive Wassermann. "Injury" to palm right hand		17 perforations of ileum; 1 lacerated wound of cecum; 1 perforation of rectum; slight amount of hemorrhage	Ileorrhaphies (17); proctorrhaphy (1); cecostomy	L.
F. O'R. 15	F.	20	W.	1 (entrance) just below and left of xiphoid and 1 (exit) 2.5 inches to left of third lumbar vertebra	2 hrs.	5 months' pregnancy		1 gastrohepatic perforation; moderate amount of hemorrhage	Exploration; suture of gastrohepatic omentum; removal of blood clots	L.

GUNSHOT WOUNDS (*Continued*)

Initials and Case No.	Sex	Age	Color	Number and Site of External Wounds	Duration from Time of Injury until Operation	Associated Injuries and Other Findings	Symptoms and Physical Findings	Findings at Operation	Procedure	Result
L. M. 16	F.	49	C.	1 (entrance) left sixth anterior intercostal space	2 hrs 20 mins	"Injury" to right breast	B.P. 115/80, P. 120, R. 26. Shock. Abdominal tenderness	2 perforations of anterior surface of stomach; 2 perforations of liver; large amount of hemorrhage	Hepatorrhaphies (2); gastrorrhaphies (2)	L.
W. M. 17	M.	29	W.	(Multiple) above and over crest of ileum	3 hrs.		P. 108. Shock. Abdominal rigidity	Retroperitoneal hemorrhage extending between leaves of sigmoid and descending mesocolon; laceration left ureter; 3 perforations of ileum; slight hemorrhage	Ileorrhaphies (3); introduction of ureteral catheter	L.
S. W. 18	M.	28	C.	1 (entrance) near and to right of umbilicus	3 hrs. 20 mins		B.P. 108/80, P. 96, R. 26	Very slight hemorrhage	Ileorrhaphies (3); introduction of ureteral catheter	L.
C. L. 19	F.	25	C.	2 (entrance) through abdominal wall and 2 through thigh	12 hrs. 40 mins.	2 gunshot wounds of right thigh	B.P. 126/80. Abdominal tenderness and rigidity	Extraperitoneal hemorrhage; 2 perforations of ileum; subserous hematoma of cecum; laceration of meso-appendix; perforation of fundus of uterus with hemorrhage into broad ligament; large amount of hemorrhage	Ileorrhaphies (2); appendicectomy; cecostomy (1)	L.
D. R. 20	M.	19	C.	1 (entrance) left buttock and 1 (exit) left anterior abdominal quadrant	1 hr. 45 mins.			Extraperitoneal hemorrhage; 2 lacerations of jejunum; 2 perforations of sigmoid; 1 perforation of omentum; small amount of hemorrhage	Sigmoidorrhaphies (2); jejunorrhaphies (2); closure of laceration of omentum	L.
F. M. 21	M.	41	C.	1 (entrance) below and to left of umbilicus	1 hr.	Positive Wassermann. Sliding left inguinal hernia	B.P. 106/60	Retrosigmoid hematoma; 3 lacerations of jejunum; 1 perforation of jejunal and sigmoid mesentery; moderate amount of hemorrhage	Jejunorrhaphies (3); ligation of mesenteric lacerations; hernioplasty	L.

W. deJ. 22	M.	26	W.	1 (entrance) just below xiphoid	3 hrs. 45 mins.		Pain in right chest and abdomen; abdominal rigidity. Shock	Right perinephritic hematoma; extensive lacerations of dome and posterior surface of liver; moderate amount of hemorrhage	Exploration and introduction of drain	D.
J. F. 23	M.	16	W.	1 (entrance) site not recorded	8 hrs. 10 mins.		P. 124, T. 101.8, R. 24. Pain in lower right abdominal quadrant	Extravasation of urine; perforation of rectum; perforation of bladder; small amount of hemorrhage	Exploration and introduction of drain; suprapubic cystotomy	D.
E. G. 24	M.	26	C.	"Multiple wounds"	6 hrs. 45 mins.	Multiple wounds of right forearm	B.P. 96/60, P. 120, T. 98, R. 24	Perforation of ileum; perforation of bladder; large amount of hemorrhage	Ileorrhaphies (15); cystorrhaphy; suprapubic cystotomy; ileostomy	D.
S. H. 25	F.	45	C.	Not recorded	1 hr. 30 mins.	Wound of right forearm	Severe abdominal pain. Severe shock	Left perirenal hematoma; 2 lacerations of stomach; multiple lacerations of jejunum; contusion of sigmoid; laceration of liver; laceration of gastrocolic omentum; laceration of omentum; large amount of hemorrhage	Gastrorrhaphies (2); Murphy resection of jejunum; repair of omentum; plication of sigmoid; gauze packs to liver lacerations	D.
V. T. 26	F.	16	C.	1 (entrance) right upper quadrant of abdomen	2 hrs.	Injury to spinal cord	B.P. 112/68, P. 133. T. 101, R. 40. Abdominal tenderness and rigidity	Perforation of bile duct; perforation of pancreas; perforation of jejunal mesentery; slight amount of hemorrhage	Exploration and introduction of drains to region of bile duct and pancreas perforations	D.
M. M. 27	F.	23	C.	2 (entrance); 1 (exit), sites not recorded	7 hrs. 20 mins.	Positive Wassermann. Spinal cord injury	P. 100, T. 101, R. 24	Retrosigmoid hematoma; laceration of sigmoid; slight amount of hemorrhage	Exploration; sigmoidorrhaphy; removal of bullet	D.
E. W. 28	M.	23	C.	1 (entrance) first sacral vertebra, 1½ inches to right of midline	1 hr.		B.P. 96/70, P. 88, T. 96, R. 20. Severe abdominal pain. Marked shock	Several lacerations of ileum; 2 perforations of sigmoid; perforation of ileal and sigmoid mesentery; large amount of hemorrhage	Resection 4 inches of ileum; sigmoidorrhaphies (2); removal of bullet; ligation of mesenteric perforations	D.

GUNSHOT WOUNDS (*Continued*)

Initials and Case No.	Sex	Age	Color	Number and Site of External Wounds	Duration from Time of Injury until Operation	Associated Injuries and Other Findings	Symptoms and Physical Findings	Findings at Operation	Procedure	Result
M. Y. 29	F.	21	C.	1 (entrance) right costal margin; 1 (entrance) 1 inch above and to right of umbilicus	1 hr. 10 mins.		P. 100. Severe abdominal pain, tenderness and rigidity. Moderate shock	Perforation near neck of gallbladder; perforation of right lower lobe of liver; moderate amount of hemorrhage	Exploration; cholecystorrhaphy; cholecystostomy	D.
W. R. 30	M.	28	W.	1 (entrance) above and to left of umbilicus; 1 (entrance) below and to left of umbilicus	2 hrs. 20 mins.	Gunshot wounds left buttock, forearm and shoulder. "Chest" injury	B.P. 58/40, P. 104. R. 12. Severe shock	3 perforations of jejunum; 5 perforations of ileum; 6 perforations of ileal and jejunal mesentery; moderate amount of hemorrhage	Ileorrhaphies (5); jejunorrhaphies (3); suture of mesenteric perforations (6)	D.
M. R. 31	M.	42	W.	1 (entrance) left midaxillary line at seventh interspace; 1 (exit) 1 inch to right of midline posteriorly at twelfth thoracic vertebra	6 hrs. 50 mins.	"Chest" injury	B.P. 105/80, P. 108, R. 28. Shock	Perforation of left kidney; perforation lower pole of spleen; moderate amount of hemorrhage	Exploration; removal of blood clots and liquid blood; ureteral catheterization	D.
G. R. 32	M.	22	C.	Not recorded	6 hrs. 30 mins.		P. 142. Shock	1 perforation of stomach; 3 lacerations of jejunum; 1 perforation transverse colon; perforation of jejunal mesentery; moderate amount of hemorrhage	Gastrorrhaphy; resection of jejunum; enterorrhaphy; colorrhaphy (1)	D.
J. S. 33	M.	36	W.	1 (entrance) below costal margin in posterior axillary line	2 hrs. 20 mins.	Gunshot wounds of right shoulder area; left forearm	B.P. 92/58, P. 68, T. 97, R. 18. Shock	Retroperitoneal hematoma; 1 perforation of splenic flexure of descending colon; contusion of sigmoid; moderate amount of hemorrhage	Plication sigmoid (1); colorrhaphy (1)	D.
G. S. 34	M.	46	C.	1 (entrance) in midline of upper abdomen; 1 (exit) right "posteriorly"	2 hrs. 50 mins.	Positive Wassermann	B.P. 90/50, P. 94. Shock	Retroperitoneal hematoma; perforation of upper pole of right kidney; perforation of anterior upper part of right lobe of liver; moderate amount of hemorrhage	Exploration; removal of blood clots and liquid blood	D.

P. S. 35	M.	28	C.	1 (entrance) right lower abdomen; 1 (exit) right sacral region	50 mins.		B.P. 88/50, P. 120	18 perforations of ileum; perforation of ileal mesentery; large amount of hemorrhage	Ileorrhaphies (18); plication of ileum; suture of perforation of mesentery	D.
STAB WOUNDS										
V. C. 36	M.	35	W.	"One wound"	5 hrs. 30 mins.			Perforation of prostate; perforation of rectum; perforation of neck of bladder	Cystorrhaphy; suprapubic cystotomy	L.
L. C. 37	M.	39	W.	"One wound"	1 hr.	Wound of left arm and forearm; "chest" injury	Abdominal pain	Evisceration of ileum	Exploration; replacement of eviscerated small bowel	L.
E. D. 38	F.	42	C.	"One wound"	3 hrs. 40 mins.			Evisceration of jejunum (8 ft.); evisceration of transverse colon	Replacement of eviscerated viscera	L.
A. L. 39	F.	25	C.	"One wound"	1 hr. 10 mins.	Positive Wassermann; "chest" injury right side	B.P. 106/68. Shock	Evisceration of omentum; slight hemorrhage	Exploration; excision of omentum	L.
C. McC. 40	M.	41	C.	One wound, left eleventh intercostal space in midscapular line	2 hrs. 40 mins.	Positive Wassermann; left lower chest injury with pneumothorax	B.P. 130/80, P. 114, R. 28	Incised wound of left diaphragm	Lumbar exploration; resection twelfth rib; transpleural repair of diaphragm	L.
D. P. 41	M.	30	W.	"One wound," right upper abdominal quadrant	1 hr. 5 mins.		B.P. 180/90	Slight hemorrhage	Exploration; internal closure of stab wound	L.
W. S. 42	M.	19	C.	Not recorded	50 mins.			Incised wound left kidney	Lumbar exploration; partial resection of twelfth rib	L.
J. W. 43	F.	30	C.	One wound in left ninth intercostal space in midaxillary line	1 hr. 5 mins.	"Chest" injury		Incised wound of stomach; evisceration of stomach and transverse colon	Gastrorrhaphy; replacement of eviscerated viscera; repair of diaphragm	L.
A. C. 44	M.	22	C.	One wound above and to right of umbilicus	2 hrs. 20 mins.	"Chest" injury; injury to left arm	B.P. 96/72, P. 96, T. 98, R. 50	2 perforations and 2 abrasions of stomach; slight amount of hemorrhage	Gastrorrhaphies (2); plication stomach (2)	D.
H. K. 45	M.	19	W.	One wound in right "groin"	8 hrs. 30 mins.	Injury to right femoral artery and vein	B.P. 80/60, P. 140. Severe pain in lower abdomen	Evisceration of omentum	Ligation of femoral vein; suture of femoral artery; excision of omentum	D.
G. McD. 46	M.	73	W.	One wound of left "flank"	4 hrs. 40 mins.	"Chest" injury	P. 132. Abdominal tenderness and rigidity	Evisceration of jejunum (10 ft.); one incised wound of jejunum	Plication of serosa of jejunum; jejunorrhaphy; replacement of intestines	D.

The mesentery was injured in many gunshot wound cases in this series. The injuries frequently occurred through avascular areas or near the attachment of the mesentery to the intestine, and in such cases, large vasa recta were not injured, so there was a relatively small amount of intraperitoneal bleeding, and no hematoma formation between the leaves of mesentery. In some cases, however, injuries of the mesentery occurred in the central zone of the mesentery, and were associated with injuries to the mesenteric blood vessels, with resulting extravasation of blood and formation of hematomata between the leaves of mesentery. This second class of mesenteric injuries constitutes a more serious problem because of the difficulty of either locating the ends of the injured vessel or of satisfying one's self that adequate spontaneous hemostasis has occurred and will prevent subsequent bleeding. A third type of mesenteric injury deserves special consideration, *i.e.*, mesenteric injuries occurring exactly at the junction of the mesentery with the intestine, and associated with a dissecting hematoma between the leaves of the mesentery. Such injuries require especially close examination in order that it may be determined whether or not there has been partial or complete rupture of the intestinal wall in addition to injury of the mesentery. A fourth type of mesenteric injury, and certainly the most serious of all, is that which occurs near the base of the mesentery, for in this region either injury to, or ligation of, a mesenteric blood vessel interferes with the blood supply to a large segment of intestine. Furthermore, determination of the location, character, and extent of blood vessel injury in this portion of the mesentery is particularly difficult on account of the obscuring hematoma which rapidly develops between the leaves of the mesentery.

Injuries to the gastrocolic, gastrohepatic, or hepatoduodenal omenta may be more or less serious, depending upon the presence or absence of important blood vessel damage or upon the proximity of the injury to the junction of the mesentery with the stomach or intestine. The gastrohepatic mesentery was injured in two cases in this series, both of which lived; and the gastrocolic mesentery was seriously injured in one case, which died.

The great omentum, because of its usual large size, is particularly likely to be injured in penetrating wounds of the abdomen, and injury to omental blood vessels may be responsible for most of the intraperitoneal hemorrhage in some penetrating wounds of the abdomen. Extensive injury to the omentum occurred in two gunshot wound cases. In the stab wound group, evisceration of the omentum occurred in two cases. In several instances, especially in the stab wound cases, the omentum was found to be plugging an opening in the abdominal wall, thus preventing the evisceration of loops of intestine, while in other instances it was found applied over and at least partially sealing intestinal perforations.

Perforations of either hollow or solid viscera are likely to be overlooked in the course of operations for penetrating wounds of the abdomen. Such oversight may result either from the hurried procedure which is necessary in the presence of such injuries, or because of obscuring hematomas. Billings and Walking,[60] Wilson,[18] and Oberhelman and LeCount[55] have drawn attention

to the frequency with which unrepaired perforations are discovered at autopsy. Thorough examination, particularly of the hollow viscera, after all perforations are thought to have been repaired may well precede closure of the peritoneum, if the patient's condition warrants such a recheck. Rectal perforations are

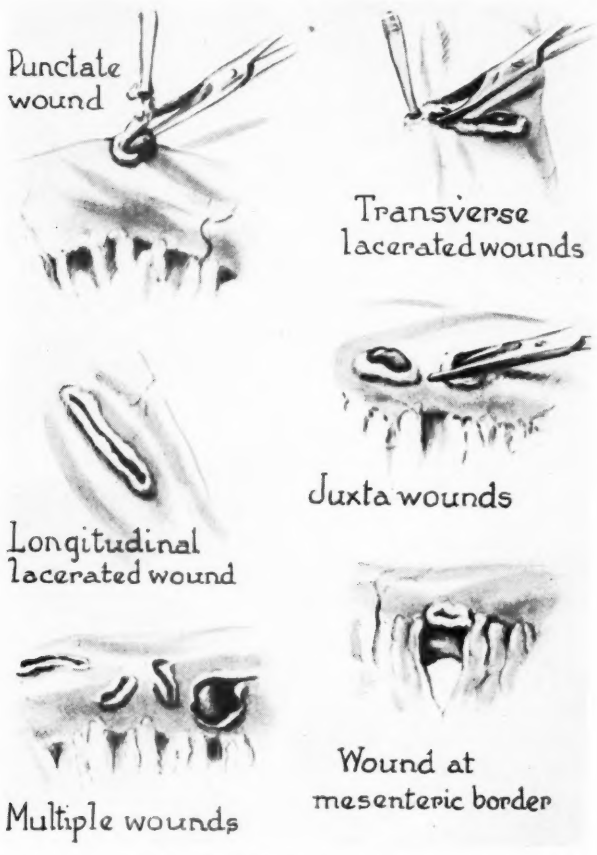


FIG. 5.—Drawing illustrating the various types of penetrating wounds of the intestines. Multiple wounds, such as those shown at the lower left, should be closed separately rather than treated by resection of the segment in which they are located. Wounds at the mesenteric border, such as that shown at the lower right, are particularly likely to be overlooked or imperfectly closed, because of their location and because of the obscuring hematoma, which frequently forms between the leaves of the mesentery.

especially likely to be overlooked in gunshot wound injuries in which the bullet has entered in the gluteal, sacral, or perineal regions. Furthermore, extraperitoneal hemorrhage is particularly likely to obscure or conceal rectal wounds, even during exploration of the abdomen. Table II shows the various injuries and operative procedures in the present series of cases. Figure 5 illustrates the various types of intestinal injuries found.

Operative Procedures.—The operative procedures performed in the present series are shown in Table II. Abdominal exploration and evacuation of liquid blood and blood clots were effected in six cases in which almost no other

procedure was necessary or feasible. Several of the cases in which only exploration and removal of blood were undertaken had inaccessible penetrating wounds of the dome of the liver. In one gunshot wound case, the only injury found at operation was a penetration of a blood vessel in the gastrohepatic omentum, and the sole procedure, in addition to removal of blood and blood clots from the lesser peritoneal cavity, consisted of ligation of the bleeding vessel and closure of the opening in the gastrohepatic omentum. In another case, in which there was a punctate injury of the spleen, with no bleeding at the time of operation, the only procedure was the removal of blood and blood clots. Whenever a perforation was discovered in either the stomach or intestine, examination was made for a possible second penetrating wound in the nearby opposite wall. When a perforation on the anterior wall of the stomach was discovered, the lesser peritoneal sac was opened and the posterior wall of the stomach examined for a possible second penetrating wound. Prey and Foster[59] found that enlargement of the wound in the anterior wall of the stomach was the simplest and quickest method of revealing, as well as repairing, wounds involving the posterior wall of the stomach.

Method of Closure of Perforations.—Perforations of hollow viscera were usually repaired by means of interrupted or continuous through-and-through sutures which were sometimes supplemented by the introduction of Lembert sutures or Cushing right angle sutures. Purse-string sutures were employed in closing some of the perforations and frequently these were supplemented by a second purse-string suture or by sutures introduced in Lembert or Cushing fashion. Small caliber braided silk on a straight round needle was used for the introduction of the through-and-through, Lembert, or purse-string sutures in the stomach and intestines. Figure 6 illustrates various methods of closing perforations of hollow viscera. When intestinal resection was undertaken, chromic catgut No. 0 or 1, on atraumatic needles, was used for the interlocking through-and-through and loop-on-the-mucosa sutures, and silk was used for seromuscular suturing. On the basis of the results following intestinal resection in comparison with the results, even when many closely located intestinal perforations or lacerations were closed independently, it appears that intestinal resection should be performed only in the presence of an absolute indication. Oberhelman and LeCount[55] have also concluded that in only a few instances is resection of viscera or parts of viscera necessary. When resection is resorted to, some type of end-to-end anastomosis other than by means of Murphy button and preferably by one of the "aseptic" or "closed" methods is preferable to side-to-side anastomosis. Less "turn-in" or spur formation can usually be better assured by employing the Furniss[61] method.

The performance of enterostomy, in anticipation of ileus, is unwarranted. The results obtained by means of enterostomy are unsatisfactory and there is a danger of producing intestinal obstruction either through the production of stenosis or angulation at the site of enterostomy, or through the development of a volvulus about the loop of intestine which is fixed to the abdominal wall.

Furthermore, the objectionable and dangerous effects, including excessive loss of fluids, which are likely to follow jejunostomy and sometimes even ileostomy, suggest that enterostomy should seldom, if ever, be performed in cases of penetrating wounds of the abdomen. This attitude in respect to the performance of enterostomy has been partly due to the development of safer and more efficient methods for the prevention of distention of the small intestine, such as the maintenance of continuous suction through an indwelling

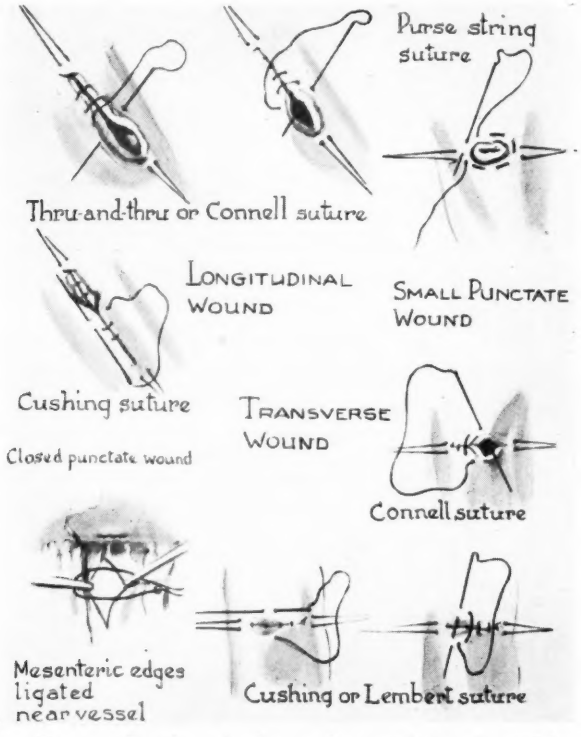


FIG. 6.—Drawing showing various methods of repairing perforations of hollow viscera. The figure at the lower left indicates the method of repairing defects in the mesentery by ligation rather than by suture closure of the defect, which latter procedure entails the risk of perforating mesenteric vessels which are obscured by a hematoma between the leaves of the mesentery.

gastroduodenal catheter, or even a Miller-Abbott tube, and the hypodermic administration of large doses of morphine.

Hepatorrhaphy was performed in two gunshot wound cases in which extensive stellate or lacerated wounds were present. Heavy chromic catgut was used to approximate the liver surfaces. In addition to gauze packs which were used in several instances to control bleeding from the liver, hot compresses were applied directly to the exposed liver surfaces during the operation, and in still other instances, strips of rectus muscle were removed, macerated, and applied to the bleeding surfaces.

The mesentery of the small intestine was repaired in nine instances in the

gunshot wound group. Although the amount of bleeding from the mesentery was slight to moderate in most instances, in two cases very active bleeding from blood vessels in the mesentery was observed at the time of operation. In none of the stab wound cases was there occasion to repair the mesentery. On account of the danger of strangulation or puncture of vessels in the mesentery or omentum, which is likely to occur when these structures are sutured, mesenteric or omental defects, both small and large, were usually closed by grasping the divided mesentery or omentum at opposite points with forceps and tying together the portions of mesentery or omentum within the grasp of forceps as shown in the lower left illustration in Figure 6.

When evisceration of the omentum had occurred, the eviscerated omentum and the surrounding abdominal wall was cleansed, traction on the omentum was made until previously nonprotruding omentum was withdrawn, and the eviscerated omentum was then resected. The ligated stump of omentum was replaced just before the abdomen was opened for exploration. Aside from the importance of arresting hemorrhage, accurate closure of defects in the mesentery and omentum was effected in order to prevent the occurrence of internal herniae.

With the exception of one stab wound case, all kidney injuries in this series were associated with other visceral injuries. In no case was nephrectomy performed, because what is considered to be the only absolute indication for nephrectomy in penetrating wounds of the abdomen, *i.e.*, extensive injury in the region of the renal hilum, was not recognized in any instance. Gauze packs or cigarette drains were introduced through the injury in the kidney and allowed to exit through the lumbar bullet or stab wounds or through a surgically made stab wound in the lumbar region. Wounds in the peritoneum overlying the kidney were sutured to prevent hemorrhage or leakage of urine into the peritoneal cavity. The extensive perirenal hemorrhage usually present made exact location of the kidney injuries difficult. Since extravasation of urine in the retroperitoneal space is likely to result from obstruction to the outflow of urine caused by blood clots in the pelvis of the kidney or in the ureter, a large indwelling ureteral catheter was introduced up to the pelvis of the kidney in several of the gunshot wound cases. The ureteral catheters were aspirated or even gently irrigated at frequent intervals following operation. Also, ureteral catheterization was performed preoperatively in three cases in the gunshot wound group in which injury to the ureter or bladder was suspected either because of the course of the bullet or because of preoperative hematuria.

Closure of wounds of the urinary bladder, or plication of the bladder wall in instances of incomplete penetration of the bladder, was performed in three instances in the gunshot wound group.

Transpleural repair of an incised wound of the diaphragm was performed in one instance in the stab wound group in which the knife causing the incised wound of the diaphragm entered the thorax and traversed the pleural cavity.

The injury in this instance occurred on the left side and, before closure of the diaphragmatic wound was effected, the chest wall wound was enlarged and the cardiac portion of the stomach was drawn through the opening in the diaphragm and inspected. A punctate wound of the right diaphragm was found in one of the gunshot wound cases in which the dome of the liver was penetrated. Because of the practical impossibility of suturing such wounds transperitoneally, and because of the likelihood of adequate spontaneous shutting off of the communication between the chest and abdominal cavities by the close application of the liver to the diaphragm, no attempt was made to repair this injury. Transabdominal repair of the diaphragm was performed in one case in the stab wound group in which there was associated evisceration of intestine and stomach.

Lumbar exploration of the abdomen following resection of the twelfth rib was performed in two cases of the stab wound group in which the patient had received stab wounds in the lumbar region. A rubber tissue flap was placed over a "sucking" stab wound of the chest in one case, in order to prevent the development of tension pneumothorax. Within the limits permitted by the patient's general condition, a careful and complete débridement of associated injuries to such structures as the breast, the hand, and other extra-abdominal structures was done. Ligation of the femoral vein, and arteriorrhaphy of the femoral artery, was done in one of the stab wound cases.

Exposure of and ligation of actively bleeding veins in the space of Retzius was necessary in one case in the gunshot wound group in which an extensive perivesical hematoma was present. Exploration of and ligation of veins in the broad ligament was also required in one instance in which a dissecting hematoma extended into the lateral perivesical space. Extruded hollow viscera were cleansed with normal saline solution and perforations in them were sutured before the viscera were replaced in the abdomen, and before finally placing drapes in preparation for celiotomy.

Irrigation or lavage of the peritoneal cavity was employed in only one instance—a gunshot wound case in which considerable spillage of intestinal contents had occurred. Although this patient lived, it is believed that peritoneal lavage should rarely be done. Because of the time required to even partially remove foreign material by this means, and because of the likelihood of causing disseminated contamination, peritoneal lavage is not only likely to be valueless, but it is probably harmful. On the other hand, postoperative morbidity and mortality may be considerably reduced by picking out, sucking out, or sponging out any liquid blood, blood clots, detached particles of viscera, intestinal contents, wadding, bullets, or particles of clothing found within the peritoneal cavity.

Prolonged search for bullets was not made at the time of operation. Unless the patient's condition was very good, only those bullets which were incidentally found were removed at the time of the principal operation. In several instances, bullets were found lying free in the abdominal cavity; in one

instance a bullet was found lodged in the cecal wall; while in still another case a bullet was found lodged in the wall of the sigmoid.

Bullet wounds of entrance and exit were usually débrided at the time of operation, but even the slight prolongation of anesthesia necessary to permit such débridement was sometimes considered unwarranted. In some instances drains or packs were conducted through enlarged wounds of entrance or exit.

One or two cigarette drains were introduced in nine of the gunshot wound cases which lived. In five of these cases, the drain was introduced through a stab wound made at the time of operation, and located in most instances lateral to the principal incision, although in two instances the drain was placed at one end of the celiotomy incision. In one instance, the drain passed through an enlarged bullet wound of entrance, while in still another instance the drain was passed through an enlarged wound of exit. One or two cigarette drains were also used in six of the gunshot wound cases which died; in two cases the drain was introduced through a surgically created stab wound; in two instances through the principal operative incision; and in two instances through an enlarged bullet entrance wound. A single cigarette drain was used in one of the stab wound cases which lived, the drain being introduced through a stab wound made at the time of operation. In two stab wound cases which died, the drains were brought out through the original stab wounds. Because of the impossibility of draining the peritoneal cavity and because of the danger of intestinal obstruction resulting from the introduction of drains into the peritoneal cavity, the intraperitoneal introduction of drains at the time of operation for penetrating wounds of the abdomen is now considered futile.

Closure of the abdominal operative incision was, in most instances, accomplished by means of continuous No. 2 chromic catgut sutures for approximation of the peritoneum and transversalis fascia, interrupted No. 2 chromic catgut for approximation of skin and subcutaneous fat, and for retention sutures. It is felt, at present, that better wound healing can be obtained by using interrupted sutures of braided or twisted silk throughout the layered closure of such wounds. Even though the operative incisions in penetrating wounds of the abdomen are usually contaminated, the significant findings of Shambaugh and Dunphy,[62] concerning various suture materials in relation to the healing of contaminated or infected wounds, indicate that less serious wound infections and fewer wound ruptures are likely to occur when silk ligature and suture material is employed. Cotton thread may also be employed in preference to catgut for ligatures and sutures.

Rubber tissue drains, placed between or beneath the rectus muscle and either beneath or above the anterior rectus sheath, were usually introduced and allowed to remain in place for from 48 to 96 hours before being completely removed. Drainage of the operative wound in cases of penetrating wounds of the abdomen is particularly advisable, as a safeguard against the possible fatal intraperitoneal rupture of an abdominal wall abscess.

Duration of Operation.—The duration of operation in cases in which this factor was recorded averaged 60 minutes in the survival group, and 82 min-

utes in the fatal group, as shown in Figure 7. That a direct relationship exists between the duration of operation and the mortality in penetrating wounds of the abdomen is certainly to be expected, and Oberhelman and LeCount[55] have for this reason strongly advised the avoidance, if at all possible, of time-consuming procedures such as intestinal resection.

Postoperative Course, Including Postoperative Complications.—Nausea or vomiting occurred in only 11 cases in the gunshot wound group. In the stab wound group, nausea or vomiting occurred in three cases. Postoperative pain of considerable degree was present in only nine cases in the gunshot wound group and in three cases in the stab wound group. Postoperative distention was present to a considerable degree in 11 cases of the gunshot wound group and a notable degree of ileus occurred in three cases in the stab wound group. The relatively low incidence of the above distressing postoperative symptoms was no doubt, in large measure, due to the employment of indwelling gastric or duodenal catheters, and to the administration of adequate doses of sedatives as well as to the routine application of heat to the abdomen.

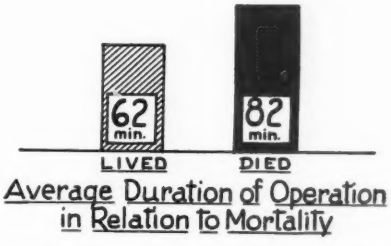


FIG. 7.—Graphic representation showing the influence of the duration of operation upon the mortality in the present series of cases.

Peritonitis was recorded as occurring in only four cases in the combined group, with one survival and three deaths, the only instance of survival occurring in a gunshot wound case. The remaining two gunshot wound cases and the one stab wound case died. There were evidently many more instances of peritonitis, both in the group which lived and the group which died, than is indicated by these figures. In fact, peritonitis must have played an important part in practically all of the fatalities, with the exception of those cases in which death was due to shock and hemorrhage. Careful observations for postoperative residual abscess such as subphrenic and culdesac abscesses, and the proper drainage of such purulent accumulations constitute an important part of the postoperative observation and treatment of penetrating wounds of the abdomen.

An intestinal fistula persisted in one gunshot wound case and necessitated a subsequent operation for its closure. The management of intestinal fistulae has been considered in an excellent review by Hartzell.[63] Although no patient in this series developed a pancreatic or duodenal fistula, it is noteworthy that bronzing powders may be applied to advantage for the protection of the skin and for the prevention of the digestion of the abdominal wall which usually accompanies pancreatic, duodenal, and high jejunal fistulae. Also, the employment of some sort of suction apparatus to continuously remove outpouring secretions affords symptomatic relief and hastens the closure of such fistulae.

Pulmonary atelectasis, pneumonia, and pulmonary embolism are particularly likely to occur in patients who have had penetrating wounds of the abdomen. Hemorrhage, shock, and relatively prolonged anesthesia without

benefit of adequate preanesthetic preparation, as well as postoperative peritonitis and ileus, frequently coexist or occur in sequence in patients with gunshot wounds of the abdomen. Transfusion, ample hydration, early mobilization, the application of heat, avoidance of tightly applied dressings, and the encouragement of forced, deep breathing, as well as postoperative hyperventilation by means of carbon dioxide-oxygen inhalations immediately after operation and during the subsequent postoperative period, as has been variously suggested by Snyder,[64] Cutler and Hunt,[65] Sante,[66] and Henderson,[67] are all methods which may be advantageously and effectively employed to minimize pulmonary complications. The postoperative aspiration of mucus from the respiratory tract by means of a catheter introduced immediately following operation or sometimes during the later postoperative period may also at times serve to prevent or relieve postoperative pulmonary complications. Aspiration of mucus with the aid of a bronchoscope may occasionally be necessary, but the proper application of other simpler methods makes bronchoscopic drainage rarely necessary.

Considerable infection of the operative wound occurred in eight gunshot wound cases, seven of which lived. There were no serious operative wound infections among the stab wound cases. Postoperative wound rupture or evisceration occurred in one gunshot wound case, necessitating secondary closure of the wound. This patient died. Separation of wound edges without evisceration occurred in two gunshot wound cases, both of which lived. The use of interrupted silk sutures instead of catgut for closing the operative incision might have averted the wound ruptures.

Jaundice, due to absorption of large amounts of blood pigment from the retroperitoneal space or peritoneal cavity, occurred postoperatively in one gunshot wound case. Other miscellaneous postoperative complications included a second degree burn of the thigh, produced by a hot water bottle. One of the stab wound cases which survived developed bilateral vasitis, epididymitis and a scrotal abscess. Sudden unexplained collapse, evidently the result of embolism, was followed by death in one stab wound case.

Postoperative Treatment.—Postoperative treatment consisted in many instances of continuing measures which had been instituted either preoperatively or during the operation. In addition to external heat applied by means of hot water bags, a heat tent was placed over the abdomen in practically all cases.

At one time or another during the postoperative period of most of the cases of this series, either the head or the foot of the bed was elevated six to twelve inches. When patients were in shock, the foot of the bed was elevated, whereas when spillage into the peritoneal cavity of material which might lead to the formation of a subphrenic or residual abscess had occurred, the head of the bed was elevated. Relatively large amounts of morphine were administered for the relief of pain, to secure rest, and for the tone stimulating effect of this drug on the intestinal musculature. It is remarkable that the erroneous belief that morphine causes ileus has persisted, following the demonstration by Gruber[68] of the tone and peristaltic stimulating influence of this drug. The

desirable influence of morphine in the presence of ileus has been demonstrated by Ochsner, Gage, and Cutting.[69] Intravenous hypertonic, lactated Ringer's solution, in a 20 times normal concentration and in amounts varying from 6 to 12 cc., may be employed to advantage to increase intestinal tone and peristaltic activity in the presence of ileus.

An indwelling gastroduodenal catheter, introduced through the nose, was used postoperatively in a total of 25 cases in the combined gunshot and stab wound groups. Fifteen of these cases lived and ten died. Postoperative gastric lavage with warm saline or sodium bicarbonate solution was performed in a total of 13 cases in the combined group, nine of which lived and four of which died. Although careful postoperative gastric lavage may be employed to advantage when the stomach has been penetrated and contains liquid or clotted blood, the performance of gastric lavage is usually not necessary or advisable. Immediate postoperative introduction of an indwelling catheter attached to a suction apparatus almost always obviates the need for gastric lavage. The indwelling catheter should be of large size, with many perforations, and it should be left in place until a normal pyloric balance has been established.

Enemata and colonic flushes were given to 19 of the gunshot wound cases. Seven of the stab wound cases received enemata and flushes. Since the abdominal distention which occurs postoperatively in penetrating wounds of the abdomen is principally due to ileus of the small intestine, enemata and flushes are likely to be ineffectual. Exhaustion or increased discomfort of the patient as well as an increase of the degree of ileus and distention is likely to follow repeated large flushes. During convalescence, and after recovery from adynamic ileus has occurred, small purgative enemata may sometimes be safely and advantageously administered. A colon tube was inserted in several instances for the purpose of facilitating the elimination of accumulations of gas in the large intestine.

Surgical pituitrin was administered to seven of the gunshot cases, three of which lived and four of which died. The clinical and experimental demonstration by Ochsner, Gage, and Cutting[69] that pituitary extract usually fails to produce an increase, and may even cause a decrease, of intestinal tone and peristaltic activity, indicates that this drug should seldom, if ever, be used in attempts to relieve ileus. Of the drugs which are commonly employed for the purpose of stimulating peristalsis, eserine or prostigmine methylsulphate appears to be most effective. The observations of Fine and Hermanson,[70] indicating the favorable influence of a high concentration of oxygen in the lung alveoli in causing reduction of intractable distention, can be advantageously applied in the postoperative management of ileus associated with penetrating wounds of the abdomen. Oxygen therapy for the relief of ileus may be administered by means of a catheter introduced through the nose; by means of an oxygen tent; or by employing the method developed by Boothby,[71] Lovelace[72] and Bulbulian.[73]

Secondary or delayed enterostomy was not undertaken in any case in either

group. Since the development of superior methods of treating ileus, this usually futile procedure has little place in the postoperative management of penetrating wounds of the abdomen. The Miller-Abbott tube may prove of value in selected cases of postoperative intestinal obstructions, particularly of the water-hose kink variety.

Postoperative transfusion of either whole or citrated blood was administered in a total of 13 cases, six of which lived and seven of which died. The average amount of blood given was 673 cc. The six gunshot wound cases which lived received an average of 600 cc., and the six gunshot wound cases which died received an average of 820 cc. In all of the gunshot wound cases, the citrate method was used. The only stab wound case which received a transfusion was given 300 cc. of untreated blood. Although more frequent and larger postoperative transfusions of whole blood might have averted several of the fatalities in this series, the several factors already referred to in the discussion of preoperative transfusion frequently made adequate transfusion impossible.

The methods now available for quick determination of plasma protein levels, including the falling-drop method[48] and the Bing-bead method,[49] now make it relatively easy to ascertain that this blood constituent is at the level necessary for proper wound healing and other reparative and regenerative processes. A lowered plasma protein level is likely to result from the necessary restriction of adequate amounts of protein derived from oral feeding. Plasma protein depletion is a factor in defective wound healing; it may also lead to the complete occlusion of the intestinal lumen at a site which has been narrowed during the repair of perforations, with resulting complete obstruction such as has been shown to sometimes occur at the ostomy of gastro-enterostomies. Leakage along suture lines and at the sites of repair of intestinal perforations has no doubt in some cases been due to inadequate fibrin formation. Peritonitis, resulting from such leakage, has surely been responsible for some of the deaths following penetrating wounds of the abdomen, and might have been prevented by the administration of adequate transfusions of whole blood, or the administration of lyophilized serum.

Infusions, which in many instances were administered as a continuous intravenous drip, were given to ten cases, the average amount being 700 cc. Eight of these patients died, five of the deaths occurring in the gunshot wound group, which received an average of 1,000 cc. of 5 per cent glucose and normal saline. The one gunshot wound case which lived received 2,500 cc. of a mixture of 10 per cent glucose and normal saline. Three of the four stab wound cases which received infusions died. The fatal stab wound cases which were given infusions received an average of 2,500 cc. of 10 per cent glucose. In addition to the infusions, an intravenous drip of 10 per cent glucose and saline was administered to three gunshot wound cases, all of which died after receiving an average of 4,000 cc.

Hypodermoclyses were usually administered in the subcutaneous tissues of the medial aspects of the thighs rather than in the subcutaneous tissues of the

chest. These clyses consisted of a mixture of equal parts of 10 per cent glucose and normal saline and were administered to practically all cases in both groups during the postoperative period. For the combined groups, the average amount given was 3,451 cc., those which lived receiving an average of 3,904 cc., while those which died received an average of 2,615 cc. The gunshot wound cases which lived received an average of 4,060 cc., while those which died received an average of 2,927 cc. The stab wound cases which lived received an average of 3,125 cc., while those which died received an average of 1,000 cc.

Insulin, given for the purpose of buffering glucose in infusions, was administered to four patients in an average dose of 46 units, for the combined group. In the combined group, those patients who were given insulin and lived, received an average of 55 units, while those who received insulin and died were given an average of 37 units. Two gunshot wound patients who received insulin and lived were given an average total dose of 32.5 units. There is no record of any fatal gunshot case having received insulin. Of the two stab wound cases, one of which lived and one of which died, each received a total of 60 units. The administration of insulin along with glucose of more than 5 per cent concentration is particularly advisable in view of the demonstration by Ochsner, *et al.*,[57] of the peristaltic inhibiting effect exerted by glucose of more than 5 per cent concentration.

Adhesive plaster strapping of the chest was done on one gunshot wound case, who had an associated chest injury. Aspiration of the pleural cavity was necessary in another case in which there was an associated hemothorax.

In a few cases in which postoperative bleeding occurred, various "hemostatic" drugs were employed. "Antivenin" was given intramuscularly in the case of one gunshot wound case which died: "ceanothyn" was administered orally in repeated doses of one or more ounces to two gunshot wound cases, one of which lived and one of which died; "coagulen," in doses varying from 3 to 25 cc., intramuscularly, was given to four gunshot wound cases, two of which lived and two of which died; parathyroid hormone, in doses varying from 5 to 30 units, was administered to four gunshot wound cases, two of which lived and two of which died; calcium chloride was given intravenously in doses of from 15 to 45 gr. to three gunshot wound cases, two of which lived and one of which died. Calcium lactate was administered to one gunshot wound case which lived. In several instances, two or more hemostatic agents were administered to the same patient. These drugs were either given singly or in such varying combinations that, especially in consideration of the small number of cases in which they were used, no conclusions could be drawn concerning the efficacy of any of them. Epinephrine hydrochloride was administered hypodermically or intravenously to 14 of the combined gunshot and stab wound cases. The average total amount given to four cases in the combined group which lived was six minims, while the average amount received by ten cases which died was 15.6 minims. Unless a large dose seemed absolutely necessary, the epinephrine was administered hypodermically in

repeated doses of two or three minims, every one or two hours, or even more frequently. In still other cases, the epinephrine was added to a saline or glucose infusion. Despite the undesirable cardiovascular effects of epinephrine, its administration in some cases seemed to be imperative. Furthermore, although epinephrine causes depression of intestinal tone and inhibits peristaltic activity, restoration or maintenance of the blood pressure may necessitate the use of this drug. Because of the damage of the suprarenal glands which may be associated with ileus due to peritonitis, adrenal cortical extract might be used to advantage in penetrating wounds of the abdomen associated with ileus. The preparation of desoxycorticosterone acetate, as employed by Thorn, *et al.*,[74] in Addison's disease, might be employed for this purpose.

Caffeine sodium benzoate was administered to 14 of the patients in the combined gunshot and stab wound groups. Combining the gunshot and stab groups, the amount of caffeine sodium benzoate administered was 7.5 gr. in one case which lived, while in 13 cases which died the average total dose was 16.5 gr.

Digitalis preparations were administered subcutaneously, intramuscularly, or intravenously to a total of 11 cases. Although all but two of the patients who received digitalis died, every one of these patients was in extremely poor condition. The absence of strikingly beneficial effects of digitalis might be expected in such cases as those in this series, who had a simple sinus tachycardia without disturbance of the normal conduction mechanism. Under such circumstances, digitalis is not effective in improving cardiac efficiency and may even exert only a toxic effect.

The important rôle which the vitamins play in wound healing, resistance to infection, and in maintaining liver function makes the postoperative administration of ample amounts of concentrated vitamins by parenteral or oral routes, as suggested by Vorhaus,[75] obviously important in the instance of patients who are recuperating after penetrating wounds of the abdomen.

Urinary antiseptics, *i.e.*, "serenium," "pyridium," or methenamine and sodium acid phosphate, were administered to a total of five cases in the combined group, all of which lived. These drugs were employed either for the treatment of established urinary tract infections or for prophylaxis when suprapubic cystotomy had been performed, or when indwelling ureteral catheters were installed. Except during the time when bladder irrigations were being performed, a small catheter connected to a suction apparatus was kept inserted in the suprapubic tube with the tip of the small catheter reaching to or beyond the tip of the surrounding catheter, in order to keep the bladder empty.

Antiluetic treatment was administered postoperatively to six patients in the combined group, three of which lived and three of which died. Mercurialism, manifested by stomatitis and salivation, was observed in one of the gunshot cases receiving "mixed" treatment postoperatively. This condition improved rather rapidly following the discontinuance of the mercury preparation, and the patient lived.

Perfringens serum was given postoperatively to one gunshot wound case which lived. Polyvalent antianaerobic serum might have been advantageously administered to some cases. The coli-bactragen, advocated by Steinberg[76] for the prevention of peritonitis, and such chemotherapeutic agents as sulfanilamide and sulfapyridine were not available during the period in which the cases in this series were observed, but may possibly be of value in cases of peritonitis resulting from penetrating wounds of the abdomen.

Mortality.—The mortality in the present series of cases, as shown in Figure 8, although comparing favorably with other comparable series, is discouragingly high. Had the methods which are at present applicable in the management of penetrating wounds of the abdomen been available, and had all these improved methods been consistently applied in the treatment of the cases included in this report, it is reasonable to expect that the mortality might have been considerably lower. Although, because of the very nature of such injuries, the mortality in penetrating wounds of the abdomen will inevitably remain relatively high, the constant improvement in methods of treating shock, hemorrhage, ileus, and peritonitis is encouraging.

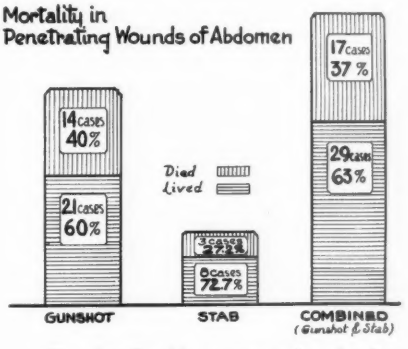


FIG. 8.—Graphic representation showing the mortality in the present series of penetrating wounds of the abdomen.

SUMMARY AND CONCLUSIONS

(1) The present report is based on 46 personally managed cases of penetrating wounds of the abdomen, 35 of which were gunshot wounds, and 11 of which were stab wounds.

(2) Facilities for quick transportation, arrangements to shorten the preoperative duration of the injuries, and provisions for promptly combating shock and hemorrhage are important in the management of penetrating wounds of the abdomen.

(3) The symptoms associated with penetrating wounds of the abdomen are frequently indefinite. Pain is frequently slight or absent. Penetrating wounds of the abdomen which occur via the gluteal, sacral, or perineal regions are particularly likely to be overlooked because of the frequent absence of early symptoms.

(4) Physical findings in penetrating wounds of the abdomen may be misleading. Tenderness and rigidity are not constantly present.

(5) Examination of the urine for gross or microscopic blood should be made in order to reveal or confirm the presence of injuries of the urinary tract.

(6) Red blood cell counts and hemoglobin determinations may be misleading or late indicators of hemorrhage.

(7) Roentgenologic examination is often of value in the preoperative determination of probable injuries.

(8) The recognition of associated injuries, particularly those of the chest, is important in the management of penetrating wounds of the abdomen.

(9) Study of wounds of entrance and exit may indicate whether or not penetration of the abdomen has occurred. When there is uncertainty concerning penetration of the abdomen, exploratory celiotomy usually should be performed. Even when the wounds have been produced by small-sized shot, abdominal exploration should be performed.

(10) A short interval between the time of injury and the time of operation usually favorably influences the outcome, but operations should be delayed until patients have at least considerably recovered from shock. In upper abdominal penetrating wounds, operation may be necessary and is relatively safe during a longer period than in wounds which involve the lower portions of the abdomen.

(11) Prolonged shock produces irreversible deleterious effects; therefore, attempts should be made to rapidly combat shock and hemorrhage.

(12) The extent of hemorrhage largely determines the outcome in penetrating wounds of the abdomen. In the presence of considerable hemorrhage, transfusions during and shortly after operation and totaling as much as 3,000 cc. of blood may be necessary. Transfusion registries and blood banks are important in making available adequate supplies of blood. Transfusions of blood should, whenever possible, displace the administration of saline or glucose infusions or stimulant drugs.

(13) Spinal anesthesia may be employed to advantage in selected cases.

(14) The ricochet of bullets, as well as variations in the relative position of parts of the patient's body at the time of injury, as compared with the position of the same parts on the operating table, accounts for apparently bizarre courses of bullets. Unexpected and unpredictable visceral injuries due to the position of the patient, or the phase of respiration at the time of injury, were frequently observed. The specific injuries observed in the present series of cases are listed in Table II.

(15) The total number of perforations of either hollow or solid viscera was only slightly less in the group which lived than in the group which died.

(16) Whenever perforation of one wall of a hollow viscus is detected the opposite wall of the viscus should be examined for possible injury.

(17) The mortality rate was unusually low in the group of cases with large intestine injury, probably because of the relatively small amount of spillage which accompanies such injuries.

(18) Extraperitoneal hemorrhage or hemorrhage between the leaves of the mesentery is likely to obscure important injuries.

(19) Injuries of the gallbladder, bile ducts, pancreas and kidneys are extremely serious. Perforations of the spleen usually require splenectomy. Hemorrhage from lacerations of the liver may sometimes be satisfactorily

sutured, but in other instances hemorrhage from lacerated surfaces of the liver can best be controlled by means of packs.

(20) Unrepaired perforations are frequently discovered at autopsy; therefore, reexamination after all perforations are thought to have been repaired is advisable if the patient's condition warrants such a procedure.

(21) Because of the important relationship between hemorrhage and mortality, attention during operation should be directed first to the arrest of bleeding.

(22) Time-consuming procedures, such as intestinal resection, should be avoided whenever possible.

(23) Mechanical anastomosis devices should rarely if ever be used.

(24) Enterostomy is usually ineffectual, and has been displaced by better methods of preventing or combating ileus.

(25) Drains introduced into the peritoneal cavity are usually unnecessary and undesirable, but drainage of the abdominal wall should be instituted when hollow viscera have been perforated.

(26) Silk or cotton sutures and ligatures are superior to catgut for the repair of hollow viscera and for the closure of the abdominal wall.

(27) Irrigation or lavage of the peritoneal cavity is usually futile, but it is desirable to suck out or pick out from the peritoneal cavity liquid blood, blood clots, detached particles of viscera, intestinal contents, and foreign bodies.

(28) Postoperative attention should include measures to combat any still-existing shock or effects of hemorrhage.

(29) The application of heat to the abdomen, the administration of large doses of morphine, the establishment of gastroduodenal suction drainage, the avoidance of enemata and flushes, and the infusion of glucose and lactated Ringer's solution are effective measures in preventing or reducing the severity of ileus and peritonitis. The Miller-Abbott tube as well as oxygen therapy may be employed to advantage in selected cases.

(30) Biologic preparations, such as coli-bactragen, and chemotherapeutic agents such as sulfanilamide and sulfapyridine may prove of value in reducing the mortality from peritonitis resulting from penetrating wounds of the abdomen. Desoxycorticosterone acetate, or other preparations containing the adrenal cortex hormone, may benefit those cases in which peritonitis is anticipated or already exists.

(31) Vitamins should be administered parenterally or orally to favor wound healing and to compensate for the general vitamin deficiency which is likely to develop during the postoperative period.

(32) Lyophiled serum or whole blood transfusions are sometimes necessary to maintain plasma protein at a normal level during the postoperative period.

(33) Atelectasis and pneumonia frequently complicate penetrating wounds of the abdomen; therefore, measures should be taken to prevent or promptly treat these pulmonary complications.

(34) The mortality of penetrating wounds of the abdomen is, and will

surely continue to be, disappointingly high. In the present series, the mortality in the stab wound cases was 27.2 per cent; the mortality in the gunshot wound cases was 40 per cent; and the combined mortality was 37 per cent. However, recent advances in the treatment of shock, hemorrhage, ileus and peritonitis, all of which are so important in the management of penetrating wounds of the abdomen, are encouraging.

BIBLIOGRAPHY

[1] Miles, A. B.: Report of a Case of Gunshot Wound of the Abdomen. Southern Surg. and Gynec., Trans., **3**, 436, 1890.

[2] Parker, W. E.: Bullet Wounds of the Abdomen. Southern Surg. and Gynec. Trans., **9**, 272, 1896.

[3] McRae, Floyd W.: Penetrating Wounds of the Abdomen: Report of Cases. Southern Surg. and Gynec. Trans., **11**, 22, 1898.

[4] Crofford, T. J.: Peritonitis, with Perforation of Small Intestine. Gunshot Wound of the Abdomen, with Thirteen Perforations. Southern Surg. and Gynec. Trans., **12**, 200, 1899.

[5] Grant, H. H.: Treatment of Gunshot Wounds of the Abdomen: Some New Statistics. Southern Surg. and Gynec. Trans., **12**, 37, 1899.

[6] Wysor, John C.: Report of a Case of Gunshot Wound of the Abdomen. Southern Surg. and Gynec. Trans., **14**, 178, 1901.

[7] Fenner, E. D.: Penetrating Wounds of the Abdomen: Histories of Six Laparotomies and Statistical Tables of 152 Cases Operated Upon at the Charity Hospital, New Orleans, La. Southern Surg. and Gynec. Trans., **14**, 180, 1901.

[8] Neff, Wallace: Gunshot Wounds of the Abdomen. Southern Surg. and Gynec. Trans., **14**, 363, 1901.

[9] Caldwell, C. E.: Penetrating Wounds of the Abdomen: Report of Cases. Southern Surg. and Gynec., Trans., **18**, 398, 1905.

[10] Guerry, LeGrand: Report of Eight Consecutive Cases of Gunshot Wound of the Abdomen, with One Death. Southern Surg. and Gynec. Trans., **20**, 348, 1907.

[11] McRae, Floyd W.: Penetrating Wounds of the Abdomen. Southern Surg. and Gynec. Trans., **21**, 236, 1908.

[12] Mason, J. M.: The Influence of Hemorrhage on the Mortality in Gunshot Wounds and Other Injuries of the Abdomen: An Analysis of 69 Cases. Trans. Southern Surg. Assn., **35**, 36, 1922.

[13] Mason, J. M.: The Influence of Hemorrhage on the Mortality in Gunshot Wounds and Other Injuries of the Abdomen: A Supplementary Report; with Analyses of 127 Cases. Trans. Southern Surg. Assn., **36**, 499, 1923.

[14] Bunch, George H.: Shotgun Wounds of the Abdomen. Trans. Southern Surg. Assn., **41**, 38, 1928.

[15] Willis, Byrd Charles: Penetrating Wounds of the Abdomen Received from Pistol, Rifle, and Shotgun Missiles: Report of 63 Cases. Trans. Southern Surg. Assn., **44**, 114, 1931.

[16] Willis, Byrd Charles: Shotgun Wounds of the Abdomen. Trans. Southern Surg. Assn., **47**, 215, 1934.

[17] Willis, Byrd Charles: Shotgun Wounds of the Abdomen: Report of Experimental Work. Am. Jour. Surg., **28**, 407, 1935.

[18] Wilson, Frank C.: Gunshot Wounds of the Abdomen. Southern Med. Jour., **27**, 805, 1934.

[19] Storck, Ambrose H.: Gunshot Wounds of the Abdomen, I. A Consideration of Their General Management: Report of Thirty-Five Personal Cases. Southern Surg., **8**, 148, 1939.

[20] Matas, Rudolph: Personal communications.

[21] Loria, Frank L.: Visceral Injuries in Gunshot Wounds of the Abdomen. New Orleans Med. and Surg. Jour., **80,** 283, 1927–1928.

[22] Loria, Frank L.: Prognostic Factors in Abdominal Gunshot Wounds. New Orleans Med. and Surg. Jour., **83,** 393, 1930–1931.

[23] Loria, Frank L.: The Influence of Hemorrhage in Abdominal Gunshot Injuries. ANNALS OF SURGERY, **96,** 169, 1932.

[24] Miller, Martin O.: Gunshot Wounds of the Abdomen: The Immediate End-results in 46 Cases, New Orleans Med. and Surg. Jour., **80,** 279, 1927–1928.

[25] Bastos, M.: Sobre el pronóstico en los heridos de guerra del vientre. Rev. san. de guerra, **2,** 1, 1938.

[26] Butler, E.: Injuries of Chest and Abdomen. Surg., Gynec. and Obstet., **66,** 448, 1938.

[27] Capruciu, G.: Case of Bayonet Wound with Multiple Intestinal Perforations and Acute Peritonitis. Rev. san. mil. Bucuresti, **36,** 417, 1937.

[28] Cubbins, W. R., Callahan, J. J., and Scuderi, C. S.: Thoracic Wall Injuries Complicated by Lesions to Thoracic and Abdominal Viscera: Emergency Treatment. Nebraska Med. Jour., **23,** 11, 1938.

[29] Culligan, J. M.: Perforating Wounds. Minnesota Med., **22,** 397, 1939.

[30] Gomez Durán, M.: Anatomía topográfica de las heridas penetrantes de vientre. Semana méd. españ., **1,** 143, 1938.

[31] Gilorteanu, I., and Ionesco, V.: Plaie pénétrante bipolaire de l'abdomen par baïonnette; guérison sans intervention. Rev. de Chir., Bucuresti, **40,** 129, 1937.

[32] Gilorteanu, I., and Gostescu, P.: Sequels of War Wounds of Abdomen. Rev. sans. mil., Bucuresti, **36,** 135, 1937.

[33] Guillaume-Louis, P.: Le diagnostic des "gros genoux." Hôpital, **26,** 286, 1938.

[34] Jones, E. M.: Abdominal Injuries. Minnesota Med., **21,** 828, 1938.

[35] Kreuschner, P. H.: Injuries to Right Upper Abdominal Quadrant. Illinois Med. Jour., **74,** 419, 1938.

[36] Lanzillo, F.: Ferita d'arma da fuoco dell' ipocondrio sinistro con scoppio del rene sinistro e della milza e ferita passante dello stomaco e del fegato. Riforma med., **54,** 1281, 1938.

[37] Maass, J.: Algunas modificaciones en la exploración y terapéutics de urgencia en las heridas del abdomen. Cir. y cirujanos, **6,** 317, 1938.

[38] Meyer, K., and Shapiro, P. F.: Treatment of Abdominal Injuries: Collective Review. Internat. Abstr. Surg., **66,** 245, 1938 (in Surg., Gynec. and Obstet., March, 1938).

[39] Mitchiner, P. H., and Cowell, E. M.: Air Raid: Abdominal and Pelvic Injuries. Lancet, **1,** 469, 1939.

[40] Bergos Ribalta, F. de A.: Unas notas sobre la cirugía de guerra. Rev. san. de guerra, **2,** 24, 1938.

[41] Shipley, A. M., and Hamrick, J. C.: Abdominal Catastrophes Resulting from External Violence. Am. Jour. Surg., **42,** 542, 1938.

[42] Taylor, F. W.: Gunshot Wounds of the Abdomen. Jour. Indiana Med. Assn., **31,** 342, 1938.

[43] Gordon-Taylor, G.: Abdominal Injuries and Their Recipients. Brit. Jour. Surg., **26,** 217, 1938.

[44] Von Miorini, A.: Treatment of Gunshot Wounds under War-time Conditions. Chinese Med. Jour., **53,** 477, 1938.

[45] Wershub, L. P.: Penetrating Wounds of the Abdomen. New York Med. Coll. and Flower Hosp. Bull., **1,** 119, 1938.

[46] Wright, Louis T., Wilkinson, Robert S., and Gaster, Joseph L.: Penetrating Stab Wounds of the Abdomen and Stab Wounds of the Abdominal Wall: Review of 184 Consecutive Cases. Surgery, **6,** 241, 1939.

[47] Granger, Amedée: Device for the Localization of Foreign Bodies by Means of the X-ray. New Orleans Med. and Surg. Jour., **70,** 585, 1918.

[48] Kagan, B. M.: Simple Method for Estimation of Total Protein Content of Human Plasma and Serum—Falling-drop Method. Jour. Clin. Invest., **17**, 373, 1938.
[49] Bing, J.: Serum Protein Determination by Glass-bead Method. Acta med. Scandinav., **96**, 403, 1938.
[50] Eisberg, H. B.: Diagnosis and Treatment of Penetrating Abdominal Wounds. Am. Jour. Surg., **5**, 145, 1928.
[51] Schoenberg, H. B.: Subcutaneous Visceral Injuries. New York Med. Jour., **118**, 500, 1923.
[52] Silleck, W. M.: Penetrating Wounds of the Abdomen. Am. Jour. Surg., **37**, 3, 1923.
[53] Winslow, Nathan: Penetrating Abdominal Wounds. Surg., Gynec. and Obstet., **34**, 617, 1922.
[54] Davis, J. W.: Gunshot Wounds of the Liver. Mil. Surg., **77**, 239, 1935.
[55] Oberhelman, H. A., and LeCount, E. R.: Peace-Time Bullet Wounds of the Abdomen. Arch. Surg., **32**, 373, 1936.
[56] Condict, W. L.: Perforated Gunshot and Stab Wounds of the Abdomen—Treated at Gouverneur Hospital, New York. ANNALS OF SURGERY, **80**, 51, 1924.
[57] Ochsner, Alton, and DeBakey, Michael: Effect of Insulin and Glucose on Normal and Obstructed Intestine, Proc. Soc. Exper. Biol. and Med., **29**, 264, 1931.
[58] Waters, R. M.: Study of Morphine, Scopolamine, and Atropine, and Their Relation to Preoperative Medication and Pain Relief. Texas State Jour. Med., **34**, 304, 1938.
[59] Prey, Duval, and Foster, J. M., Jr.: Gunshot Wounds of Abdomen: Review of 22 Cases. ANNALS OF SURGERY, **99**, 265, 1934.
[60] Billings, Arthur E., and Walking, Adolph: Penetrating Wounds of the Abdomen. ANNALS OF SURGERY, **94**, 1018, 1931.
[61] Furniss, H. D.: Instrument for Intestinal Anastomosis. Am. Jour. Surg., **23**, 379, 1934.
[62] Shambaugh, P., and Dunphy, J. E.: Postoperative Wound Infections and Use of Silk: An Experimental Study. SURGERY, **1**, 379, 1937.
[63] Hartzell, John B.: Treatment of Fistula of the Small Intestine. Surg., Gynec. and Obstet., **66**, 108, 1938.
[64] Snyder, H. E.: Postoperative Atelectasis. ANNALS OF SURGERY, **102**, 5, 1935.
[65] Cutler, E. C., and Hunt, A. M.: Postoperative Pulmonary Complications. Arch. Surg., **1**, 114, 1920.
[66] Sante, L. R.: Massive (Atelectatic) Collapse of Lung—Especial Reference to Treatment, J.A.M.A., **88**, 1539, 1927.
[67] Henderson, Y.: The Physiology of Atelectasis. J.A.M.A., **93**, 96, 1929.
[68] Gruber, C. M., and Robinson, P. I.: Intestinal Activity in Unanesthetized Dogs as Influenced by Morphine and Papaverine. Jour. Pharmacol. and Exper. Therap., **37**, 101, 1929.
[69] Ochsner, Alton, Gage, I. M., and Cutting, R. A.: The Value of Drugs in the Relief of Ileus. Arch. Surg., **21**, 924, 1930.
[70] Fine, J., Banks, B. M., and Hermanson, L.: Treatment of Gaseous Distention of the Intestine by Inhalation of 95 Per Cent Oxygen: Description of an Apparatus for the Clinical Administration of High Oxygen Mixtures. ANNALS OF SURGERY, **103**, 375, 1936.
[71] Boothby, W. M.: Oxygen Administration: Value of High Concentration of Oxygen for Therapy. Proc. Staff Meet., Mayo Clinic, **13**, 641, 1938.
[72] Lovelace, W. R., II: Oxygen for Therapy and Aviation: Apparatus for the Administration of Oxygen or Oxygen and Helium by Inhalation. Proc. Staff Meet., Mayo Clinic., **13**, 646, 1938.
[73] Bulbulian, A. H.: Design and Construction of Masks for the Oxygen Inhalation Apparatus. Proc. Staff Meet., Mayo Clinic, **13**, 654, 1938.
[74] Thorn, G. W., Howard, R. P., Emerson, K., Jr., and Firor, W. M.: Treatment of Addison's Disease with Pellets of Crystalline Adrenal Cortical Hormone (Syn-

thetic Desoxy-corticosterone Acetate) Implanted Subcutaneously. Bull. Johns Hopkins Hosp., **64**, 339, 1939.

[75] Vorhaus, M. C.: Hypervitamin Therapy in Surgical Practice. Am. Jour. Surg., **42**, 350, 1938.

[76] Steinberg, B.: Experimental Background and Clinical Application of Escherichia Coli and Germ Tragacanth Mixture (Coli-Bactragen) in Prevention of Peritonitis. Am. Jour. Clin. Path., **6**, 253, 1936.

DISCUSSION.—DR. RUDOLPH MATAS (New Orleans, La.): It is unfortunate that Doctor Storck's valuable paper should have come up too late for adequate discussion. Despite the great progress accomplished in abdominal surgery, penetrating, and especially *gunshot*, wounds of the abdomen still remain the gravest of our major hospital emergencies. It is, therefore, fitting that our Association, representing as it does all that is distinctive or typical of the surgery of the South, should continue to be, as in the past, the repository of the collective and most authoritative experiences and opinions on this subject. We are not only concerned in the problem surgically, but sociologically because the frequency of homicidal gunshot wounds, in general, and of the abdomen in particular, have contributed to establish our disgraceful reputation for uncontrolled "gun toting" and "most murderous nation in the world." I am particularly interested in Doctor Storck's paper because it reflects the present experience of the Charity Hospital of New Orleans, in which I have been deeply concerned as a visiting surgeon and teacher during the 47 years that I was active in its staff (1880–1927) and, as you see, am still interested despite my present consultant status.

No one who is familiar with this hospital, or who has systematically studied its annual reports, can fail to be impressed by the extraordinary opportunities that it offers for the study of gunshot wounds, in general, and of the abdomen in particular.

Interested in the sociologic, racial and surgical aspects of the subject, I undertook, in 1891, a statistical inquiry into the incidence of gunshot wounds in New Orleans with special reference to those of the abdomen, which up to that time had not been regarded as surgical. Part of this material was contributed to Dr. F. Byron Robinson's Intestinal Surgery published the same year. Again, in 1901, assisted by Mr. Edward Hynes, we compared the prevalence of gunshot wounds of the abdomen with other institutions, and found that the admissions in the Charity Hospital for the decennium 1890–1900, alone, exceeded those of nine other general hospitals in Boston, New York, Philadelphia, Cincinnati and St. Louis, for the same period, the combined hospitals totaling 205 cases against the Charity Hospital's 234 cases.

The same evidence of our hospital's unenviable superiority in homicidal gunshot wounds was confirmed later in statistics collected for Major Lagarde's Military Treatise on Gunshot Injuries (1914). These satistical studies were particularly utilized for my lecture to military classes of the Medical Reserve Corps, established at the Charity Hospital under my direction by the Surgeon General, in 1917–1918; but the teaching value of this material was more fully exhibited in my report of 1925–1926, as Chairman of the Committee on Gunshot Wounds of the Abdomen appointed by the Staff, which showed that in 35 years (1890–1925) 1,175 patients with penetrating gunshot wounds of the *abdomen* had been admitted to the hospital, with an *average* annual mortality of 60.52 per cent.

Keeping pace with the growing population of the hospital, of the city, and of the surrounding country, the admissions for gunshot wounds in general, for the 24 years, 1904–1928, amounted to 6,075 gunshot wounds, with 1,284

deaths—including 60 per cent in Negroes. It is not surprising that Major Lagarde jokingly suggested that the students in the Army Medical School should come to the Charity Hospital for part of their military training.

From 1928 to 1939, 11 years, the general ratio of gunshot wounds, including those of the abdomen, to the hospital admissions has diminished slightly, because the admissions to the Charity Hospital were restricted to Louisiana citizens and there is less "dumping" of out of town patients into New Orleans. The mortality has also apparently diminished, as shown by Doctor Storck, but it is still fearfully high—despite transfusions and prompt surgical aid. The penetrating stab wounds, classically, retain their comparatively benign character. In a hurried survey, I find that, during 1934–1935, combined *gunshot* and *stab* penetrating wounds of the abdomen numbered 55; *gunshot* cases operated upon, 32, with a mortality in 14 instances or, 47 per cent. *Stab* wound cases numbered 23, resulting in eight deaths, or a mortality of 34.89 per cent. 1935–1936, total gunshot and stab wounds, 63, gunshot operated upon, 38, a mortality of 36.82 per cent. Stabs, 25; dead, five, a mortality of 20 per cent. The graphic representation of the mortality according to the organs involved, and the classification of other factors in the mortality, is excellent. Having lived through the early period of the 80's, when nonintervention was the rule in gunshot wounds of the abdomen, I participated in the controversies and polemics of the "abstentionists" and "interventionists," which alternately fluctuated in the practice of the hospital, in accordance with the opinions and dicta of the resident house surgeons who tenaciously controlled the Emergency Service as their special prerogative. Despite the success of Dr. A. B. Miles, who inaugurated the operative treatment of these wounds, March 8, 1891, and that this Association had unanimously adopted a resolution moved by Dr. Howard Kelly, in 1896, to the effect that "in gunshot wounds of the abdominal cavity, the proper routine procedure is to make an immediate laparotomy incision," we see that as late as *1905*, the majority of the penetrating gunshot wounds of the abdomen were treated medically, solely by rest, starvation and opium or morphine, hypodermoclysis or saline intravenous infusions.

It would be interesting to follow progress of events and note the names of the distinguished men—chiefly Fellows of this Association—who, during the last half century, gradually stabilized the principles which at present govern the treatment of these ever formidable injuries. The surgeons of to-day, who depend solely upon the printed literature for information on the history of that transition period, miss much unpublished statistical information and particularly the animation and even acrimony that pervaded some of these discussions. But the time is too limited to do more than stress the enormous importance of the experience of hospitals such as the Charity, at New Orleans, in directing and fashioning the practice of the military surgeons at the front, in the surgical problems of actual warfare, which at this moment compel universal attention.

The time for the surgical study of gunshot and other war wounds was never more opportune than at present, now that, in the clash of contending armies, countless thousands are falling hourly everywhere on the battle fronts of Europe and China from the effects of wounds inflicted by the most varied weapons and in the most diverse circumstances. With this in mind, I have prepared a synoptic glance at abdominal gunshot wounds in the late civil war in Spain, a task which has been much simplified by the publication of the carefully prepared reports of the Spanish Military Surgeons on both sides of the conflict, but particularly the Nationalist (Franco's) Surgeons who have recorded and analyzed their experience in dealing with over 1,500 gunshot

wounds of the abdomen inflicted by all variety of missiles in all imaginable conditions; and, often heroic, circumstances in which they exercised their surgical duties. As it is obviously impossible in this limited space to quote details, I will condense the information obtained from the official military journals on both sides and from my personal observation while in Spain. I will endeavor to convey the general trend of the conclusions by a few generalizations gleaned from the very recent reports of Drs. Nicolas Canto, A. J. Baron, F. Cuadrado, and G. Roldan of General Franco's Nationalist armies, and from the publications of Doctors Bastos, Bergos, and D'Harcourt in the official journal of the Republican Staff at Barcelona. As the methods of treatment were practically the same in both armies, the general conclusions arrived at by Dr. A. G. Baron (Revista Espanola de Med. y Cir. de Guerra, **2**, No. 9, 219–234, March, 1939) will serve as a sample of the general surgical experience of the Spanish Civil War. Of 500 well recorded abdominal wounds, 239 (47 per cent) were regarded as inoperable and were not celiotomized because (a) they were brought from the field in a hopeless, dying condition. In this group there were 192 of the wounded, of whom 97 per cent died; (b) in 47 of the nonoperated group, no celiotomies were performed because the visceral lesions were limited to the liver and it was thought that they had a better chance of survival without operation. The mortality in this group was 19 per cent, thereby confirming the good judgment of the surgeons in not operating. (2) Celiotomies were performed for penetrating gunshot wounds in 261 patients (52 per cent of the 500 admissions), on an average of seven and one-half hours after the injury had been inflicted. In 22 of these celiotomized patients, the lesions involved, almost exclusively, the parenchymatous organs, especially the liver; and, in this group there were 47 per cent recoveries, or a mortality of 54 per cent. (3) Two hundred forty were celiotomized for lesions of the gastro-intestinal tract, alone or conjointly with other visceral wounds. In this group only 25 per cent recovered and 75 per cent died. (4) Not included in these 500 cases were 22 exploratory celiotomies for penetrating and nonpenetrating, uncomplicated visceral injuries; the mortality in this group was 55 per cent. In addition, there were 16 patients with possibly penetrating, but, seemingly, uncomplicated wounds. In this group the mortality was only 6 per cent. (5) The great increase in artillery warfare, machine guns, explosive shells, shrapnel, hand grenades, aerial bombs, trench mortars, *etc.*, has increased the mortality of the abdominal wounds by their multiplicity and wider range of destructive action and complications (Roldan). (6) The number of fatally wounded who survived long enough from the shock and hemorrhage on the battle field to reach the casualty stations in a moribund and hopeless condition is increasing (35–47 per cent) (Baron). This is particularly characteristic of trench warfare, when the fatally wounded patients die on the field if delayed in transportation, but survive just long enough to expire in the field hospitals when the distance is short and the stretcher bearers are promptly on the spot. (7) Despite the best care and skill, the mortality of *exploratory* celiotomies is still high, 37 per cent. (8) It would seem that, despite the free and abundant resort to transfusion with whole or preserved blood, and despite favorable conditions for operation, the mortality in perforating wounds of the *gastro-intestinal* tract still remains high, 75 per cent. (9) The mortality of gunshot wounds of the abdomen involving the gastro-intestinal tract shows relatively little improvement over the mortality of the same wounds recorded in the experience of the allied French, British and American surgeons, or of German operators at the close of the World War, which was largely a stabilized trench war with surgical dugouts close by. (10) Undoubtedly, exposure in freezing temperatures, delay in

transportation, starvation, hasty mobilization of the surgical staff, and patients in mobile wars exercise a very decided influence upon the prognosis; all of which was well exemplified in the freezing winter temperatures at Teruel, the Ebro, Segre and the Pyrenean slopes. (11) It would seem that the increasing destructiveness of contemporary warfare, particularly in the multiplied and diversified phases of artillery fire, on land, air and sea, offsets and counteracts the inadequate life-saving efforts of surgical science. (12) For example, Baron quotes approvingly of Goetze's statement (1929) that "theoretically we may say that under optimum conditions of surgical technic and transportation, in warfare, it is possible to save 25 to 30 per cent of the penetrating wounds of the abdomen, who would be doomed to certain death without operation." But "when we face the cruel realities of the World War, as they apply to our [Spanish] experiences, we see that while it is true that from 1,850 to 3,700 abdominally stricken soldiers owe their lives to timely surgery by celiotomy, we also realize the relative insignificance of our contribution when we calculate that 10 per cent of the 1,185,000 soldiers killed outright on the battle fields of the World War were caused by the shock and hemorrhage of penetrating abdominal wounds! The disproportion of those saved by surgery and killed is the more apparent when we consider that fully 10 per cent of 1,185,000 killed in battle is equal to 185,000 abdominal deaths on the battle field, before any surgical assistance can possibly reach the stricken men."

BIBLIOGRAPHY OF RECENT SPANISH WAR LITERATURE ON ABDOMINAL WOUNDS

Canto Borreguero, Nicolas: Our Experience in Abdominal Wounds. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **2**, No. 5, 1–8, January, 1939.

Baron, A. G.: Immediate Results Obtained in the Field Hospitals at the Front, in the Treatment of Penetrating and Complicated Abdominal War Wounds. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **2**, No. 7, 213–224, March, 1939.

Idem: Selection of the Type of Incision in Laparotomy for War Wounds of the Abdomen, Based on an Analysis of 269 Laparotomies for Abdominal War Wounds. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **2**, No. 9, 361–372, May, 1939.

Cuadrado, Fernando: Ways of Access to Intraperitoneal War Wounds, Based on 207 Laparotomy Incisions for War Wounds. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Tomo **3**, No. 14, 267–278, October, 1939.

Duran, Gomez: Fundamental Principles in War Surgery (Includes Abdominal War Wounds). Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **3**, No. 11, 1–35, July, 1939; Tomo **3**, No. 12, 81–101, August, 1939.

Sevilla, Constantino Roldan: Abdominal Surgery in Warfare. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **3**, No. 11, 66–72, July, 1939.

Bastos, M.: On the Prognosis of Abdominal War Wounds. Revista de Sanidad de Guerra, Ano 1, Barcelona, No. 9, 1–9, January, 1938.

Bergos, Ribalta, F. de A.: Notes on the Surgery of War (Includes a Discussion on Abdominal War Wounds). Rev. de San. de Guerra, Ano 1, Barcelona **2**, No. 9, 24–46, January, 1938.

Baron, A. G.: Spontaneous Pneumoperitoneum in Penetrating and Complicated Abdominal War Wounds. Rev. Esp. de Med. y Cir. de Guerra, Ano II, Valladolid, Tomo **3**, No. 13, 173–189, September, 1939.

DR. R. A. GRISWOLD (Louisville, Ky.): I do not know whether the ice-pick is used in New Orleans or not. In Louisville it is the most lethal of all our hand-to-hand weapons. A knife usually breaks on the second or third stab but an ice-pick does not. We get a large number of multiple ice-pick

wounds, and we are not operating upon those of the abdomen except where there is evidence of hemorrhage.

Ice-pick wounds of the bowel are like birdshot wounds, in that the hole is so small that the mucosa does not evert. Consequently, leakage of intestinal content is minimal or absent and these wounds will heal themselves.

In looking over our cases of abdominal wounds we were impressed with the fact that we were performing a considerable number of unnecessary celiotomies in those borderline cases in which penetration was suspected but was not certain. During the last year, Dr. Joseph Hamilton, of the Louisville City Hospital staff, has been using the peritoneoscope in some of these borderline cases. By this means he can explore the peritoneum beneath the suspected wound, and can determine the presence or absence of penetration or of blood or intestinal contents in the peritoneal cavity. This procedure has eliminated a considerable percentage of unnecessary major celiotomies for suspected penetrating wounds of the abdomen.

FACTORS OF MORTALITY IN 4,000 OPERATIONS UPON THE EXTERNAL BILIARY SYSTEM*

CHARLES GORDON HEYD, M.D.

NEW YORK, N. Y.

FROM THE COMBINED MEDICAL AND SURGICAL BILIARY TRACT CLINIC OF THE NEW YORK POST-GRADUATE MEDICAL SCHOOL AND HOSPITAL, COLUMBIA UNIVERSITY, N. Y.

FROM January 1, 1920, to June 30, 1937, the diagnosis of gallbladder disease was made on 5,200 consecutive patients. Of this number, 3,986 were treated surgically and 309 individuals died, representing a basic mortality of 7.7 per cent. The gross mortality included every death that occurred while the patient was in the hospital irrespective of its cause.

It is not without interest, that in the 17½ years represented by this study there were two major rotations of the Surgical Staff at the Post-Graduate Hospital. The attending surgeons represented during the decade beginning 1920 were, with one exception, not on service at the beginning of 1930. The author's initial contribution to this series began in 1920, and now represents approximately one-fifth of the material studied.

An analysis of this group of now over 4,000 surgical patients was made to determine what the factors were that determined the mortalities. How many of these 309 deaths could be attributed to the calamities of surgery—the accidents, the complications over which the surgeon could exercise no control, such as embolism, apoplexy and coronary thrombosis? What mortalities were due to the unconquerable nature of the disease—the malignancies, or the patient's refusing surgical intervention at the most opportune time, or to the enfeebled condition of the patient from the ravishes of prolonged disease? What mortalities were due to lack of diagnostic skill, or to multiple surgery, or to lack of care and equipment, or the insufficiency of scientific knowledge, such as the absence of vitamin K as the controlling factor of postoperative bleeding in jaundice? What were the mortalities that may be ascribed to derelictions of surgical judgment, and what mortalities were due to lack of technical skill or inadequacy of pre- and postoperative treatment?

The 309 mortalities were the responsibility of some 53 surgeons, while 64 of the deaths among 574 cases of acute cholecystitis were the responsibility of 31 surgeons. The study emphasizes that gallbladder disease is a continuing and progressive condition. Again and again, one is impressed with the progressive character of the infective process. Primary disease in the gallbladder, with or without calculus, is followed by the development of obstructive symptoms of the cystic duct and, later, disease of the common and hepatic ducts and, finally, the development of varying types of pancreatitis and liver

* The statistical data included in this communication were studied in collaboration with Dr. R. Franklin Carter and Dr. Richard Hotz.

Read before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

disease. In general, the mortality statistics of this series correspond approximately to those of the 36,623 biliary tract operations collected by Heuer, with a gross mortality of 6.6 per cent. In a personal series of 557 operated cases, it was found that cholecystitis was associated with ulcer of the stomach and duodenum in 10.5 per cent; with jaundice in 16.3 per cent; with pancreatitis in 3.7 per cent; and with fibroids in 13 per cent. The percentage of females to males was three to one. Diabetes was present in 0.89 per cent of the patients at the time of operation, and malignancy occurred in 2.3 per cent of the cases.

If a sufficiently large number of individuals with gallbladder disease were studied, one can interpolate a series of charts indicating a progressive advancement in the pathologic invasion, a rise in the severity of the symptomatology, and an almost geometric progression in mortality. With but few exceptions, disease of the gallbladder arises in the gallbladder, and the initial infectious process is located beneath the serosa and in the wall of the gallbladder. Depending upon the virulence of the infecting organism, the resistance of the individual, and incidental and local conditions—diet, general metabolism, *etc.*—there is produced a simple type of cholecystitis which constitutes the largest number of cases for surgical intervention. Calculi were present in the gallbladders of 69 per cent of 3,306 patients operated upon for chronic cholecystitis. If the pathologic process continues unrelieved by surgery, there will ensue secondary changes in the cystic duct, the common and hepatic ducts, and eventually an infective process will involve the entire extrabiliary system. Stones in the common duct were found in 6.9 per cent of the cases of chronic cholecystitis but were present in 17 per cent of the cases of acute cholecystitis, and were found in 80 per cent of all secondary common duct operations following cholecystectomy. Calculi were present in the gallbladder in 89 per cent of the cases of acute cholecystitis.

Cholecystectomy alone, or with appendicectomy, was performed for chronic cholecystitis 2,438 times with a mortality of 3.61 per cent. Cholecystectomy was combined with choledochostomy in 7.7 per cent of the cases, with a mortality of 11.34 per cent. When gallbladder disease is complicated by common duct involvement the mortality is raised from 3.61 to 11.34 per cent. The mortality risk inherent in surgery upon the common duct is more than three times greater than the risk of simple, uncomplicated cholecystectomy (Table I). An interesting sidelight is shown in this group of cholecystectomy with common duct disease, for in the group of common duct cases with stones the mortality was 12.8 per cent, while among the cases that had common duct exploration and drainage, but were without calculi, the mortality was 3.8 per cent, not materially higher than simple cholecystectomy alone—where the mortality was 3.61 per cent. In brief, 7.7 per cent of the cases with cholecystectomy had common duct drainage, and 86 per cent of these cases had calculi in the common duct, with a mortality of 12.8 per cent; 14 of the 7.7 per cent had the common duct drained but no calculi were found, with a mortality of 3.8 per cent.

TABLE I

ANALYSIS OF 3,986 CONSECUTIVE OPERATIONS UPON THE BILIARY TRACT (1920–1937)

Operation	No. of Cases	Mortalities	Mortality Per Cent
Chronic Cholecystitis:			
Cholecystectomy	3,240	190	5.8
Alone or with appendicectomy	2,438	88	3.61
With dochostomy	238	27	11.34
With other operation	568	74	13.03
Cholecystectomy with dochostomy and other operations	6	1	16.16
Cholecystostomy	66	22	33.3
Alone or with appendicectomy	43	13	30.24
With dochostomy	16	6	37.50
With other operation	7	3	42.80
Totals	3,306	212	6.40
Obstructive Biliary Disease:			
Cholecystogastrostomy	52	15	28.8
Choledochostomy only	37	13	35.1
Choledochostomy with other operations	2	2	100.0
Plastic on ducts	5	3	60.0
Total obstructive	96	33	34.4
Acute Cholecystitis:			
Cholecystectomy	517	45	8.82
Alone or with appendicectomy	428	32	7.47
With dochostomy	89	13	14.60
Cholecystostomy	45	13	28.80
With dochostomy	9	3	33.33
Total cholecystostomy (with 3 other operations)	57	18	29.63
Total acute cholecystitis	574	64	10.97
Total for all biliary tract operations	3,986	309	7.7

Of the 3,306 operations for chronic cholecystitis, cholecystostomy was performed only 66 times, with a mortality of 33.3 per cent. This operation represented only 2 per cent of the total operations for chronic gallbladder disease. Ninety-six operations were performed for gross obstructive biliary disease, with a gross mortality of 34.4 per cent. Cholecystogastrostomy was performed 50 times, and cholecystoduodenostomy twice, with a mortality rate of 28.8 per cent. Thirty-six of the 52 anastomotic operations were for carcinoma and 16 for obstructive pancreatitis.

Thirty-nine patients entered the hospital after having had a cholecystectomy performed elsewhere. Six of the patients had had a cholecystectomy performed at the Post-Graduate Hospital. Of these 39 patients admitted, and reoperated upon, 32 of the group had recurrent or overlooked stones in the common duct. Seven had stenosis of the common duct, and choledochostomy was performed upon all 39 patients, with a mortality rate of nearly 40 per cent.

Multiple surgery is one of the most outstanding factors in increasing the mortality rate. In 575 operations cholecystectomy was combined with one or more other operative procedures, with an average mortality of 13.85 per cent, nearly four times higher than cholecystectomy alone, 3.61 per cent. These "secondary" operations were inherently dangerous, and carried their own mortality rate if performed as a single operation, namely, acute gangrenous appendicitis, gastroduodenal ulcerations, fibromyoma of the uterus, *etc.* (Table II).

TABLE II

CHRONIC CHOLECYSTITIS

Factors Influencing the Morbidity and Mortality in Surgery for Chronic Cholecystitis

	No. of Cases	Morbidity	Mortality Per Cent
(A) Multiple Surgery (cholecystectomy plus secondary operation)	575	1.72	13.85
1. With gastro-enterostomy	128	....	16.4
2. With pyloroplasty	111	....	9.9
3. With gastric resection	61	....	31.1
4. With acute appendix	31	....	13.0
5. With hysterectomy	59	....	11.8
(B) Conservative Treatment in Acute Cholecystitis			
1. Subsided acute	474	1.59	11.02
2. With chronic abscess or old perforation into colon	46	2.20	38.0
3. Cholecystostomy in previous acute	15	1.58	20.0
(C) Cholecystostomy in Chronic*	68	1.50	7.4
(D) Jaundice (especially necessitating common duct surgery)	254	....	13.0
(E) Delay in Surgery for Chronic Cholecystic Symptoms (series with less than two years' history)	959	....	1.35
Total series of chronic cholecystitis	3,303	1.31	6.4

* Means cholecystostomy for a previous chronic infection—now followed by a cholecystectomy.

Three hundred of the 575 multiple operations were for concomitant disease in the gastroduodenal segment. Only 24 were for associated malignancy of the stomach. Thus 9 per cent of the operations performed for chronic cholecystitis had surgery for associated gastroduodenal pathology, mainly ulcer. How adversely the addition to cholecystectomy of operations upon the stomach affects the mortality can readily be seen in Table II. Cholecystectomy plus pyloroplasty had a mortality of 9.9 per cent. Cholecystectomy plus gastro-enterostomy had the disproportionately high mortality of 16.4 per cent. With gastric resection added to a cholecystectomy the mortality rate was 31.1 per cent. The association of chronic cholecystitis with ulcer of the stomach and duodenum is receiving increasing attention in the current literature. That this association in surgery carries a prohibitive mortality in a large series of cases is, therefore, of great importance.

Thirty-one patients had their gallbladders removed in the presence of a pathologically acute appendix, and in four of these the appendix was perforated. The mortality rate was 13 per cent. In no instance was the gallbladder acute, though in the majority of instances it showed advanced pathology. The mortality rate of 11.8 per cent, where hysterectomy and cholecystectomy were performed, is further evidence that the patient with cholecystitis cannot well tolerate additional surgery.

The chronicity of the biliary disease was a most important factor in mortality, as is evident from the fact that among 3,306 operations for chronic cholecystitis, 959 of the patients had definite symptoms of less than two years' duration, and without any evidence of a previous acute attack. These patients had no other surgery except the cholecystectomy, with or without appendicectomy. The average age of the group was 43 years, as contrasted with the mean age of 47 years in the larger group. Only 13 deaths occurred among these 959 patients, a mortality rate of 1.35 per cent, in contrast with the general mortality of the cholecystectomy group of 3.61 per cent. There were 311 patients in whom definite symptoms had been present less than two years, but who gave a history of previous acute attacks or had secondary operations with a cholecystectomy. This group had 22 deaths, or 7.10 per cent mortality (Table III).

TABLE III

AN ANALYSIS OF THE RESULTS OF OPERATION IN CHRONIC CHOLECYSTITIS WHEN DEFINITE SYMPTOMS HAVE BEEN PRESENT LESS THAN TWO YEARS

	No. of Cases	Mortalities	Mortality Per Cent
Uncomplicated cases	959	13	1.35
Complicated*	311	22	7.10
Total operations	1,270	35	2.75

Causes of Death		Major Complications	
Pneumonia	11	Wound infections (severe)	23
Peritonitis	10	Dehiscence	15
Liver death	4	Pneumonia	8
Cardiac failure	4	Thrombophlebitis	5
Operative shock	3	Postoperative hemorrhage	4
Postoperative hemorrhage	2	Pleurisy (effusion)	3
Uremia	1	Cardiac failure	3
		Surgical erysipelas	1
		Peritonitis	1
		Acute parotitis	1

* Those with previous acute attacks or with secondary operations.

Jaundice, in any degree, was a most impressive factor in the increased mortality in chronic cholecystitis, for in 254 patients with jaundice at the time of operation, the mortality rate was 13 per cent, and 86 per cent of these patients had stones in the common duct.

Of the 3,306 patients operated upon for chronic cholecystitis, 474 gave a definite clinical history of having had a previous acute attack, and there was a definite correlation between the history and the pathologic report in 87.7 per cent (Table IV). Forty-six cases of perforation of the gallbladder occurred in so-called chronic cholecystitis, with a mortality of 19.5 per cent. Nine of these had perforations into the colon. They are included in the 474 cases reported above.

TABLE IV

THE INCIDENCE OF PERFORATED CHOLECYSTITIS

In Patients Who Have Recovered from Acute Attack and Are Subsequently Operated upon, and the Incidence in Operated Acute Cholecystitis

Pathology (Microscopic Diagnosis)	No. of Cases	Per Cent Perforated	Mortality Per Cent
Chronic cholecystitis (previous acute attack)	474	....	11.2
"Chronic" perforated cholecystitis	46	9.7	19.5
Acute cholecystitis	574	....	10.97
Acute perforated cholecystitis	69	12.1	26.1
Total cases of perforated cholecystitis	115	11.0	24.3

Cholecystostomy for chronic cholecystitis proved to be inadequate. Sixty-eight patients, after a cholecystostomy, were subsequently operated upon for recurrence of symptoms, with a mortality of 7.4 per cent, as contrasted with a mortality of 3.61 per cent for primary, noncomplicated cholecystectomy. In the Follow-Up Clinic, 54 per cent of the patients with cholecystostomy had a continuation or recurrence of symptoms. Among this group of 68 patients, 77 per cent had recurrent or overlooked calculi at the second operation.

There were 574 cases of acute cholecystitis, and the diagnosis of acute cholecystitis was made by the pathologist, after an examination of the gallbladders from 542 patients. In 32 cases no pathologic examination was made as these patients had a cholecystostomy but are classified as acute cholecystitis.

For purposes of analysis, the following pathologic designations were made: Acute cholecystitis; purulent cholecystitis; gangrenous cholecystitis; perforation with abscess; perforation with peritonitis. Acute cholecystitis included all of the cases that showed acute inflammatory change in the gallbladder but did not exhibit either empyema, gangrene or perforation. The mortality following operation in acute cholecystitis was 5.85 per cent. The mortality for purulent cholecystitis was 9.4 per cent—a higher mortality than occurred in the group with gangrenous cholecystitis, where it was 7.33 per cent. It is interesting to note that of the 574 cases, 32 had cholecystostomy and were without any pathologic report, and the mortality was 34.4 per cent, almost equivalent to the mortality of acute cholecystitis with perforation and peritonitis, namely, 35.85 per cent (Table V).

TABLE V

ACUTE CHOLECYSTITIS

Pathologic Analysis of 574 Operations

(Summary)

Pathologic Diagnosis	No. of Cases	Per Cent of Total	Mortality Per Cent
Acute cholecystitis	206	36.0	5.85
Purulent cholecystitis	117	20.4	9.40
Gangrenous cholecystitis	150	25.9	7.33
Perforated, with abscess	16	2.8	0.00
Perforated, with peritonitis	53	9.2	35.85
No pathologic report	32	5.7	34.40
Total cases	574	100.0	10.97

Cholecystostomy for acute cholecystitis was not an unmixed blessing, as even when the patients recovered from the primary operation, subsequent surgery for the retained gallbladder gave a mortality of 20 per cent.

Operations for acute cholecystitis constitute 14.5 per cent of the surgery. Thirty-six per cent of the total acute cases were classified pathologically as acute cholecystitis and 64 per cent were classified as severe acute cholecystitis. Fifty-three of the 574 cases had a free perforation with peritonitis.

The presence of calculi in the acute gallbladder did not materially increase the mortality. In chronic cholecystitis calculi were present in 69 per cent of the cases, whereas 89 per cent of acute cholecystitis had calculi. Seventy-six per cent of the acute gallbladders had clinical and pathologic evidence of a previous chronic inflammation. Of great significance was the fact that of 316 cases observed in the hospital for 18 hours or longer, 57 per cent had a progression of their symptoms and of the physical findings, 31 per cent followed a static course, while 12 per cent only, definitely subsided (Table VI).

TABLE VI

AN ANALYSIS OF THE CLINICAL COURSE OF DISEASE IN 316 CASES OBSERVED IN THE HOSPITAL FOR 18 HOURS OR MORE

Apparent Clinical Course of Disease	No. of Cases	Per Cent of Total	Mortality Per Cent
Progressive	180	57	19.3
Static	100	31	7.0
Remissive	36	12	0.0

The mortality in acute cholecystitis was remarkably influenced by preoperative hospital treatment (Table VII). In the patients that were considered "emergency" (128), and were operated upon within six hours of their admission, the mortality was 15.6 per cent, but the patients (297) that were prepared from six to 24 hours had a mortality of less than half of the previous group, namely, 7.4 per cent. Further preoperative treatment in the hospital did not improve the mortality statistics, for 56 patients operated upon from 24 to 48 hours after admission had a mortality of 10.35 per cent,

and 93 patients operated upon from 48 hours to 24 days after their acute attack had a mortality of 17.6 per cent (Table VII).

TABLE VII

THE MORTALITY AND MORBIDITY IN ACUTE CHOLECYSTITIS IN RELATION TO THE LENGTH OF PREOPERATIVE HOSPITALIZATION

Duration of Observation Period	No. of Cases	Per Cent Perforated	Mortality Per Cent
0- 6 hours.....	128	10.0	15.6
6–24 hours.....	297	13.1	7.4
24–48 hours.....	56	8.6	10.35
2–24 days.....	93	12.8	17.60
Totals.....	574	12.1	10.97

It may be assumed, therefore, that an immediate operation for an acute cholecystitis—that is, an operation within six hours after admission—is seldom indicated. Adequate preoperative treatment from six to 24 hours is sufficient to insure the best mortality statistics. The mortality rate after a few hours of preoperative therapy is slightly under that of the entire group mortality, 7.41 per cent, as contrasted with 7.7 per cent. Again, the lethal influence of jaundice becomes apparent in acute cholecystitis. Jaundice at the time of operation for acute cholecystitis increased the operative hazard, for 155 patients with acute cholecystitis complicated by jaundice were operated upon, with a mortality of 20.6 per cent, and in the patients who had acute cholecystitis but were not jaundiced at the time of their operation, but had a history of previous attacks with jaundice, the mortality among 101 patients was 15.8 per cent, contrasted with the basic mortality group of the acute cholecystitis cases operated upon between six and 24 hours, namely, 7.41 per cent.

There were 820 patients upon whom a pathologic diagnosis of mild cholecystitis was made. Many of these showed cholesterosis. Whether cholesterosis is essentially a pathologic condition is still a subject of considerable controversy. In any event, the mortality rate in this group was 1.34 per cent. The next degree in pathologic sequence indicates a disease of the gallbladder with definite infection and inflammation. The clinical symptoms become more apparent. Many of the patients have colic, and a diseased gallbladder can be readily determined by drainage and roentgenologic examination. The majority of gallbladder patients come to surgery at this stage of their disease. The mortality rises to 4.2 per cent, and the number of severe complications is doubled. The infection in the gallbladder will continue, and attacks of acute cholecystitis are apt to occur. In this group there were 474 patients operated upon for chronic cholecystitis who had clinical and pathologic evidence of former acute attacks. The operative mortality in this group was 11.20 per cent (Table VIII). Each succeeding acute attack increases the mortality by 2 per cent.

TABLE VIII

ANALYSIS OF 474 PATIENTS OPERATED UPON AS CHRONIC CHOLECYSTITIS WHO HAD CLINICAL AND PATHOLOGIC EVIDENCE OF A FORMER ACUTE ATTACK

Pathologic diagnosis of former acute attack	474
Average total duration of chronic history	9 years
Average time since last acute attack (history and clinic record)	2.8 months
Mortality rate	11.20%
Morbidity factor	1.59%

The common duct pathology found in the series falls into two groups: (1) Those conditions intrinsic to the duct; and (2) those extrinsic to it. Common duct stone was by far the most common cause for surgery upon the common duct. Choledochostomy was performed with cholecystectomy or cholecystostomy for chronic disease in 260 instances and stones were found in 82 per cent. In 3,306 operations for chronic cholecystitis, the incidence of common duct surgery was 7.7 per cent, and of stones, 6.9 per cent. Calculi were found in the common duct in 80 per cent of all secondary common duct operations after cholecystectomy. The invariable pathologic finding was an associated severe cholecystitis. This advanced pathology of the gallbladder found in common duct disease lends authority to the assumption that intrinsic common duct disease is usually secondary to gallbladder disease. That cholecystitis is a progressive disease which eventually involves the common duct has been noted repeatedly in our series.

TABLE IX

DURATION OF CHOLECYSTIC SYMPTOMS IN COMMON DUCT STONE

Duration of Symptoms	No. of Cases	Common Duct No. of Cases	Per Cent Common Duct Stone
Under 2 years	1,270	24	1.9
2–10 years	1,020	92	9.0
10–35 years	610	97	16.0

The relationship of calculi in the common duct to the duration of cholecystic symptoms is indicated in Table IX. In the 1,270 cases with symptoms of cholecystic disease of less than two years, there were 1.9 per cent with common duct stone. In 1,020 cases with symptoms from two to ten years, common duct stones were present in 9 per cent. In 610 cases with symptoms over ten years, 16 per cent had common duct calculi. Calculi in the common duct is presumptive evidence of delay in diagnosis or of surgical procrastination. In this series, 66 per cent of the cases with stones in the common duct were associated with chronic pancreatitis and chronic biliary disease. Acute pancreatitis was associated with common duct calculi in 78 per cent of the cases.

With the advent of cholangiography we have been able to exercise a more critical judgment. We have more confidence that there has been a complete restoration of function in the common duct and, furthermore, that the symptoms have been relieved and infection combated by adequate surgery.

The test is simple and readily carried out. The day before the test is to be made from 20 to 30 cc. of normal saline is allowed to flow, by gravity, from a syringe into the T-tube. The common duct will ordinarily accommodate 20 or 30 cc., with practically no discomfort. On the morning of the following day, the patient is taken to the Roentgenographic Department and from 10 to 20 cc. of sterile hippurin (50 per cent) is allowed to run into the T-tube. A roentgenogram is taken immediately at the completion of the injection. A second exposure is made four minutes later, and a third, eight minutes after the second roentgenogram, or 12 minutes after the injection. The first negative will indicate that both hepatic ducts are well filled with the solution and that the common duct is moderately distended. If the ampulla and common duct are totally unobstructed, the dye will have passed readily into the duodenum, and in four minutes may be observed in the duodenum and neighboring jejunal loops. The roentgenogram made at the end of 12 minutes will show almost complete evacuation of the dye into the small intestine.

Discussion.—From this study there emerge certain very definite conclusions. It is evident that chronic biliary disease is a continuous and progressive pathologic condition; that the mortality and morbidity of this disease varies with the chronicity of the process itself, with the intrinsic pathologic changes, with the complications, and with the physical status of the patient. Surgery for chronic biliary disease is sufficiently dangerous to be the only operative procedure performed. The outstanding death-producing conditions in order of frequency were: (a) Peritonitis; (b) pulmonary complications; and (c) varying states of hepatic insufficiency.

In regard to acute cholecystitis there is no warrant for what may be termed the "immediate" operation—that is, surgical intervention upon patients within six hours after admission to the hospital. The best results in acute cases, so far as mortality and morbidity are concerned, were obtained in the group of patients who were prepared for operation from not less than six hours up to 24 hours after their admission. Conservative treatment and watchful waiting, while they may appear temporarily successful, are eventually disastrous for the patient.

In the pathology of acute cholecystitis the mortality factor and the severity of the disease are increased when the patient has had previous attacks of icterus. Jaundice adds approximately 100 per cent to the mortality factor.

Cholecystostomy has a definitely higher immediate mortality than cholecystectomy, and has a more marked increase in the eventual mortality. Approximately 50 per cent of the patients with a cholecystostomy require reoperation, which carries with it a secondary mortality close to 20 per cent. The most successful results were obtained in the group of 959 patients who were operated upon within two years after definitely demonstrable gallbladder symptoms appeared. This low mortality, 1.35 per cent, was obtained regardless of the age of the patient, and is in contrast to the general cholecystectomy mortality of 3.61 per cent.

In the beginning of this series (1920) exploration of the common duct was

carried out only in the presence of very marked disease of the common duct or associated pancreatitis. As the precision of operative technic became thoroughly established, more common ducts were explored, with better results and less mortality. The importance of common duct disease and of primary exploration is apparent from a consideration of the statistics. Drainage of the common duct for cholangeitis, calculous or otherwise, at the first operation, and when combined with cholecystectomy, does not give a prohibitive mortality (11.34 per cent); whereas a secondary choledochostomy in a previously cholecystectomized patient has a mortality approximately 350 per cent greater than that which attends primary exploration (38.60 per cent).

The visual and palpable findings that call for an exploration of the common duct are not always clear cut or well-defined. Cutler and Zollinger give the indications for exploration of the common duct at operation as follows: (a) The suggestion of a stone on palpation; (b) a dilated or thickened duct; (c) a contracted gallbladder; (d) a dilated cystic duct; (e) a thickening of the head of the pancreas; and (f) the presence of small stones in the gallbladder or the cystic duct.

We have been impressed with a disease of the common duct not characterized by the presence of calculi but exhibiting a markedly contracted common duct, with extensive fibrosis in the walls, with an associated palpable hardness of the head of the pancreas, and a history of attacks of slight jaundice (icteric index 25–30), febrile reaction and upper epigastric distress, even to the point of severe pain. This type of disease of the common duct has been found in patients who have had a primary cholecystectomy for chronic cholecystitis with cholelithiasis, and in periods varying from two to 12 years the patients have been reoperated upon for common duct disease.

THE IMMEDIATE AND END-RESULTS OF CHOLECYSTECTOMY*

WILLARD H. PARSONS, M.D.

VICKSBURG, MISS.

FROM THE DEPARTMENT OF SURGERY, THE VICKSBURG HOSPITAL, INC., AND THE VICKSBURG CLINIC, VICKSBURG, MISS.

THE PURPOSE of this communication is to present a small group of patients who, following careful study, were operated upon for cholecystic disease. It is proposed to comment briefly upon the causes of the mortalities that occurred and, feeling that the ultimate destiny of the surgical patient is second in importance only to the immediate mortality rate, considerable effort will be made to evaluate, fairly and accurately, the final results obtained, and to attempt to determine the reason, or reasons, for the not inconsiderable number of unsatisfactory results that prevail. The study, it is hoped, may be of value, since essentially all of the patients being reported upon in this particular series lived in sufficiently close proximity to permit personal reexamination from time to time. It is felt, then, that the end-results recorded represent the true state of affairs. Also, the experiences and conclusions of certain other surgeons regarding the indications for, and results from surgery will be cited.

There can be little argument as to the very great frequency of gallbladder disease. Crump,[1] in a study of 1,000 consecutive autopsies in Vienna, found 33 per cent of the individuals to have gallstones and 60 per cent showed some form of cholecystopathy. Mentzer,[2] in a series of 612 autopsies at the Mayo Clinic, found 60 per cent of the subjects to have grossly pathologic, and 75 per cent microscopically pathologic changes in the gallbladder.

That the disease, while admittedly frequent in occurrence, is not frequently a cause of mortality is indicated by the report of Hoffman,[3] statistician of the Prudential Life Insurance Company, who says that, in 1919, only 2,887 of a total of 85,147,822 persons died of gallbladder disease. It would seem from this study (in contradistinction to certain medical experiences to be later referred to) that death directly attributable to cholecystic disease is fairly rare. That happy state of affairs does not, however, exist in patients subjected to surgery. Macdonald[4] recently found, after an international survey, that the average mortality, following surgical extirpation of the gallbladder, was 10 to 12 per cent. This figure is startlingly high (Table I), particularly so when compared with the experience of Barksdale,[8] who reports 1.3 per cent mortality following cholecystectomy; of Elkin,[7] who reports 2 per cent; of Sanders,[5] who, among 1,000 consecutive patients, had a mortality of 2.5 per cent; of the Lahey Clinic,[15] with a reported rate of 3.8 per cent; of Finsterer,[11] who reports 4.4 per cent; or of McGehee,[6] who reports 7.2 per cent fatalities following all types of operative procedures upon the biliary tract. On the contrary, Boyd,[9] in a series of 1,018 patients from the Massachusetts

* Read before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

Memorial Hospitals, reports a mortality rate of 9 per cent following cholecystectomy for chronic inflammatory disease, and 11.4 per cent for cholecystectomy for cholelithiasis, or an average mortality rate of 10.5 per cent, a figure almost indentical with that quoted by Macdonald as the average prevailing in a group of small, selected hospitals. Unfortunately, the vast majority of major surgical procedures performed in this country are executed by operators not possessed of the high grade of technical skill and excellent judgment of the surgeons just referred to, but are performed by the rank and file of the profession, many of whom are inadequately prepared to attempt such procedures. So long as that situation prevails, it is highly probable that the mortality rate the country over is, and will remain, decidedly higher than Macdonald's report indicates.

TABLE I

MORTALITY RATES FOLLOWING SURGICAL PROCEDURES UPON GALLBLADDER AND DUCTS

Barksdale[8]	1.31%
Elkin[7]	2.0%
Sanders[5]	2.5%
Lahey Clinic[15]	3.8%
Finsterer[11]	4.4%
McGehee[6]	7.2%
Boyd[9]—Mass. Memorial Hospitals	10.5%
Macdonald[4]—Collected Series	10 to 12%

MORTALITY RATES FOLLOWING MEDICAL TREATMENT OF CHOLECYSTIC DISEASE

	Died	Cured	Improved	Unimproved	Required Subsequent Surgery
Finsterer,[11] 89 patients	12.3%	39%	40%	21%	
Schittinhelm[quoted by 11]	25.0%				40.0%
Tallquist,[13] 110 patients	7.38%				21.8%
Jaguttes,[14] 114 patients	16.0%				22.8%

Mortality incident to medical treatment—16 to 25 per cent.

That there exists at present a decided difference in opinion as to the ultimate results following removal of the gallbladder, can scarcely be denied. Many internists, and some surgeons, estimate that a very definite percentage of patients following surgery are either not benefited by the procedure or are actually made worse. Kunath,[10] from the University of Iowa, reports that in the noncalculous group 69 per cent were cured or improved, and in the calculous group 84 per cent were cured or improved by cholecystectomy. Most large surgical centers feel that the end-results obtained are excellent. It seems, nonetheless, true that following cholecystectomy a definite number of individuals promptly die, and a large number fail to be benefited from the operation. Despite, however, the frequent comments of various internists concerning the poor results following cholecystectomy, there exists a striking

paucity of information from them concerning the end-results in patients treated medically. Before the results of surgical treatment are condemned or unduly criticized, the end-results accruing from, or attendant upon, medical treatment should likewise be analyzed. Finsterer[11] reports that, of 89 patients treated medically, 11 (12.3 per cent) died from gallstone trouble; seven died from perforation of the gallbladder; and two from carcinoma. Finsterer refers to other reports of series of patients treated medically, in which 39 per cent were completely or partially cured, 40 per cent were improved, and 21 per cent were unimproved. Schittenhelm[12] estimated that 40 per cent of patients discharged as "cured" following medical treatment had subsequent recurrence of attacks, and 25 per cent died or required surgery for severe complications. A study of surgical statistics shows that it is those very complications following ill-advised medical treatment that produce the majority of all surgical deaths. Tallquist[13] studied 110 patients discharged as cured following medical treatment, and of these, nine died within six years of gallbladder disease, and 24 additional individuals later required surgery (with four deaths) on account of complications. Had the remaining "cured" patients been observed longer, more would likely have been found to have had further trouble. Jaguttes[14] observed, from ten to 25 years, 114 patients treated medically. Of these, 13 died from gallstones, and five from cancer of the gallbladder, showing a total mortality of 16 per cent. An additional 26 had to be operated upon later because of the development of complications, from which group four died.

The above results, following medical treatment, do not compare favorably with the results following proper surgical management. The medical mortality in the series just quoted fluctuated from 16 to 25 per cent. The incidence of permanent recovery following medical treatment of genuine cholecystitis, and certainly of cholelithiasis, is hardly greater than the mortality rate that accompanies this form of therapeusis. It would appear from the literature available that the medical management of genuine cholecystic disease results in as many deaths as cures. Certainly that premise gains strength if we consider the grave complications which frequently follow such management for, as previously remarked, it is these very complications of medical treatment which, not rarely, make surgical intervention a necessity at a time not favorable for, and in an individual ill-prepared to tolerate, surgical attack. As an example of the latter may be cited the experience of Lahey,[15] who reports a mortality rate of 7.6 per cent following choledocholithotomy with drainage of the duct, whereas for conditions not necessitating invasion of the duct the mortality rate is far lower. The conclusion of Finsterer, who believes that 87.8 per cent of patients are cured following cholecystectomy, is approximately that prevailing in most well-conducted surgical clinics.

It will be noted that in the personal series being presented (Table II), of the patients studied 23 per cent were male and 77 per cent were female. There was an operative mortality, including patients requiring removal of stones from, or repair of, the common duct, of 6 per cent. In calculating this mor-

tality rate, all patients who died previous to discharge from the hospital, irrespective of the immediate cause of their deaths, were included.

TABLE II

DATA PERTINENT TO PERSONAL SERIES BEING PRESENTED

Total Number of Patients Studied—100
Sex— Male 23, Female 77
Total Deaths—6

Age	Sex	Jaundice	Diagnosis	Operative Procedure	Cause of Death	Time of Death
48	F.	Yes	Gangrene of gallbladder. Peritonitis	Cholecystostomy	Peritonitis	25th p.o. day
57	F.	Yes	Chr.cholecystitis. Cholelithiasis	Cholecystectomy	Peritonitis. Ileus	12th p.o. day
68	M.	Yes	Chr. cholecystitis. Cholelithiasis. Choledocholithiasis	Choledocholithotomy. Choledochostomy. Cholecystostomy	Shock	24 hrs.
55	F.	No	Subacute cholecystitis	Cholecystectomy	Coronary occlusion	21st p.o. day
73	F.	Yes	Empyema of gallbladder. Hepatic failure	Cholecystostomy	Hepatic failure	7th p.o. day
37	M.	Yes	Hydrops of gallbladder	Cholecystectomy	Hepatorenal failure	4th p.o. day

Patients jaundiced—26% (or definite history of previous jaundice).
Duct explored—16%. Found to contain calculi or strictured—15.
Patients jaundiced following surgery—1 or 1% (one transient attack only).
Patients requiring subsequent surgery for cholecystic disease—none.

Surgical procedures employed—	Cholecystectomy	93%
	Cholecystostomy	7%
	Choledochostomy	13%
	Repair of stricture of common duct	1%

It is highly significant that, with a single exception, all patients who died following operation were jaundiced at the time of surgery. That particular individual, known prior to operation to have coronary artery disease, died of acute coronary closure, on the twenty-first postoperative day, at which time she was preparing to return to her home. It is even more interesting that none died as a result of postoperative bleeding, and, in fact, not one of the patients operated upon in this particular series had postoperative bleeding, although 11 per cent, at the time of surgery, were jaundiced, an additional 15 per cent had, on one or more occasions, been jaundiced, and 15 per cent, at surgery, were found to have common duct stones or stricture of the duct. It may be remarked that in addition to those patients being now discussed, following other operative experiences in this field, that state of affairs has constantly prevailed. The failure, in my personal experience, of jaundiced patients to have a strong tendency to postoperative bleeding is in distinct contrast to the experience of Walters, Judd, Lahey and others. It may be that

patients living far South, under different climatic and dietetic conditions from the northern and eastern clinics, lack the hemorrhagic diathesis. Maes[16] says that bleeding has been rare in his experience, and that he is "not particularly fearful of deaths in patients who are jaundiced and in whom surgery of the biliary tract is indicated." During the past ten years Barksdale has had no incidence of postoperative hemorrhage. On the contrary, McGehee, Sanders, Mason,[17] Haggard[18] and Elkin have not had so fortunate an experience.

TABLE III

RESULTS IN PATIENTS SURVIVING OPERATION

Cured	66.0%
Improved	27.7%
Unimproved	6.3%

Allergy—Patients positive (20)

Cured	50.0%
Improved	40.0%
Unimproved	5.0%
Died	5.0%

Patients negative (80)

Cured	65.0%
Improved	22.5%
Unimproved	6.25%
Died	6.25%

Results—Patients having stones in gallbladder or ducts or both (35)

Died	11.0%
Cured	83.0%
Improved	6.0%
Unimproved	

Patients in noncalculous groups (65)

Died	3.0%
Cured	51.0%
Improved	37.0%
Unimproved	9.0%

Patients having duct calculi (15)

Died	13.32%

Survivors

Cured	93.0%
Improved	7.0%

Deaths subsequent to surgery—cause and time death postoperative:

Cerebral apoplexy	2 years
Cerebral apoplexy	5 years
Stab wound heart	4 years
Acute pancreatitis	4 years
Result of accident	6 years
Acute intestinal obstruction	2 years
Hepatic failure	2 years

Incidence wound evisceration—none.
Incidence postoperative hernia—2 per cent.

The question of allergy is an interesting one (Table III). Of the patients reported, 20 per cent gave a definitely positive allergic history, and of these, 50 per cent were cured, and 40 per cent were improved following operation (that is, insofar as their dyspeptic symptoms were concerned), and occasionally their allergic manifestations were relieved. This is in contrast to 65 per cent of the nonallergics who were cured, and 22.5 per cent of the nonallergics who were improved following cholecystectomy. It is worthy of comment, also, that in the presence of allergic manifestations, cholecystograms may not be of the diagnostic help that they are in the nonallergic group. It has been estimated by Lahey that the diagnostic accuracy of cholecystography in gallstones is 98 per cent. Singleton believes, further, that the function of the gallbladder can better be determined by cholecystograms than it can be judged by inspection at the time of surgery. There is little doubt that a fairly definite number of poor results occur because the patient is subjected to surgery under an erroneous diagnosis, an individual whose symptoms are the result of an allergic reaction, or disease elsewhere, being thought to have cholecystitis. The vast majority of individuals of middle age will show microscopically, changes in the gallbladder, but these findings are of little significance and do not warrant surgery. Such persons, suffering only physiologic disturbances, or having only mild pathologic changes, are not suitable candidates for surgery, and will not obtain a satisfactory result following its performance. These are the individuals who go from clinic to clinic, only to, eventually, become surgical derelicts.

Of those who had stones, 83.52 per cent were cured; 50.49 per cent, who had only cholecystitis, were cured. There were 92.28 per cent who had, in addition, common duct stones, who survived operation, and were cured. The operative mortality in the group having stones in, or stricture of, the duct was 13 per cent. In each instance in which common duct stones were found, the duct was drained for a variable period of time, generally by the use of a T-tube. Since the advent of cholangiography, all have had the tube left in place until roentgenograms indicated a normal restoration of the duct. In one instance a stone, inadvertently left behind, was successfully dealt with by the injection of ether through the common duct tube, following the suggestion of Pribram and of Walters.

Of the patients reported, 16 per cent were subjected to exploration of the common duct, and 15 per cent were found to have duct stones. In the experience of Walters,[19] common duct stones were found in 109 instances of 812 operations performed at the Mayo Clinic in 1936 (12.19 per cent). Lahey[15] reports that, in 1935, in his Clinic, the common duct was explored in 44 per cent of the cases, and stones were found in 18 per cent of the patients subjected to surgery. Walters believes that "the possibility of stones in the common bile duct being overlooked could be reduced to an absolute minimum if the common duct were always exposed as a part of the operation of cholecystectomy." Unquestionably, the dictum of the late Sir Berkeley Moynihan[20] that the duct should be explored only when stones were felt must be abandoned. The indications for exploration of the duct are reasonably

plain, and if these indications are faithfully followed, it is highly unlikely that damage will follow failure to routinely explore the duct. On the contrary, routine exploration of the duct will very definitely increase not only the morbidity but the mortality as well.

CONCLUSIONS

The immediate mortality is reasonably low and the percentage of successful end-results exceedingly high following skillfully performed procedures for actual cholecystic disease. The end-results are decidedly better in those patients operated upon for cholelithiasis than when extirpation of the gallbladder is performed for inflammation alone.

On the contrary, operations performed for mild or nonexistent gallbladder pathology, or for simple physiologic disturbances, will yield universally poor results.

Allergic individuals should be cautiously subjected to surgery, and then only provided extensive and definite symptom-producing disease of the gallbladder is present. Cholecystograms in this type of patient may be misleading.

Time, and the accumulation of a huge mass of statistics, continually confirm the criteria formerly, and frequently, laid down by Walters, Lahey, and others, regarding the indications for exploration of the common duct. Cholangiography is a definite aid in determining when to remove the tube from the common duct.

REFERENCES

[1] Crump: Quoted by Rehfus, Martin E.: The Gallbladder Problem. Rev. Gastro-enterol., **2**, No. 3, 187, September, 1935.
[2] Mentzer: Quoted by Rehfus.[1]
[3] Hoffman: Quoted by Rehfus.[1]
[4] Macdonald, Dean: A Practical and Clinical Test for Liver Reserve. Surg., Gynec. and Obstet., **69**, 70–82, July, 1939.
[5] Sanders, R. L.: Personal communication.
[6] McGehee, J. Lucius: Personal communication.
[7] Elkin, Dan.: Personal communication.
[8] Barksdale, John W.: Personal communication.
[9] Boyd, Phillips L.: The Postoperative Mortality of Cholecystitis. New Eng. Jour. Med., **218**, No. 25, 1045–1050, June 23, 1938.
[10] Kunath, Carl A.: The Stoneless Gallbladder. J.A.M.A., **109**, 183–187, July 17, 1937.
[11] Finsterer, H.: The Immediate and Permanent Results of Operative Therapy in Cholelithiasis. Wien. med. Wchnschr., **48**, 966–971, 1935.
[12] Schittenhelm: Quoted by Finsterer.[11]
[13] Tallquist: Quoted by Finsterer.[11]
[14] Jaguttes: Quoted by Finsterer.[11]
[15] Lahey, Frank H.: Stones in the Gallbladder and Bile Ducts. Surg. Clin. North Amer., **15**, 1459, December, 1935.
[16] Maes, Urban: Personal communication.
[17] Mason, James M.: Personal communication.
[18] Haggard, W. D.: Personal communication.
[19] Walters, Waltman: Abnormal Function of the Common Bile Duct Resulting from Benign Conditions. ANNALS OF SURGERY, **106**, No. 4, 726, October, 1937.
[20] Moynihan, Berkeley: Abdominal Operations. 4th Ed., W. B. Saunders & Co., Philadelphia, **1**, 642, 1926.

THE SURGICAL MANAGEMENT OF STONE IN THE COMMON BILE DUCT*

FOLLOW-UP STUDIES WITH SPECIAL REFERENCE TO GRADED DILATATION OF THE SPHINCTER OF ODDI

ARTHUR W. ALLEN, M.D.,

AND

RICHARD H. WALLACE, M.D.

BOSTON, MASS.

FROM THE SURGICAL SERVICE OF THE MASSACHUSETTS GENERAL HOSPITAL, BOSTON, MASS.

IN 1935, we[1, 2] published a method of surgical procedure for exploration of the extrahepatic bile ducts. At this time, we reported some experimental work and some clinical data relating to the method. The chief theme of the communication was the adaptation of routine, gentle dilatation of the sphincter of Oddi in all cases of common duct exploration. Prior to 1930, we had accomplished this by the very satisfactory method described by Cheever,[3] which was based on the use of stiff, woven Coudé urethral catheters. The difficulties with these instruments were those of sterilization, their tendency to become brittle and rough, and their bulk. The advantages were that fluid could be injected into them to determine their course through the papilla into the duodenum.

In 1930, our attention was called to the long, olive-shaped, graduated metal bougies of Bakeš.[4] These instruments are calibrated from 3 to 14 Mm. in diameter. The handles are of malleable metal, so that they may be shaped according to the contour of the operative field, and are soft enough to eliminate the hazard of creating a false passage. Bakeš made claims that by the employment of these dilators to a size just smaller than the diameter of the common duct, one may produce a permanent elimination of the sphincteric action of its outlet. This, he believed, enhanced the passage of stones from the hepatic ducts that had either been overlooked at exploration or that might be formed there later. His claim to permanence of dilatation was based on two instances of greatly enlarged ducts, the outlets of which had been stretched to more than 1 cm. in diameter. One patient subsequently died of gastric cancer; at autopsy the papilla admitted a 13 Mm. sound with ease—the size to which the dilatation had been carried at operation. The other passed a 14 Mm. stone nine days after dilating the papilla to 14 Mm. He, like all other surgeons who have felt that the papilla should be routinely instrumentated whenever there was indication for common duct exploration, realized that this was the surest way of providing adequate bile drain-

* Read before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

age into the duodenum; also, that the simple determination of the patency of the papilla will prove inadequate in a small percentage of cases.

It naturally occurred to us that such a practice might be attended by some danger and for this reason we approached the whole problem with considerable caution. We wished to work out a routine method that was satisfactory in our hands and that could be carried out without additional risk. By such a method we hoped to reduce the number of secondary operations for overlooked stone or for stricture and spasm of the duct outlet. We felt that we could be reasonably sure that the introduction of an instrument into the duodenum through the papilla of Vater from the open common hepatic duct was not a dangerous practice. This premise was based on the long clinical experience of many surgeons as well as our own. Also, we believe that Cheever had satisfied any question regarding the gradual dilatation of the papilla up to the diameter equal to that of a size No. 20 French catheter, or approximately 7 Mm. We did feel that we should try to ascertain the effect of such trauma and particularly to determine if, on occasion, the dilatation might be carried further with safety. The dangers of immediate infection, reflux of duodenal contents, precipitation of acute pancreatitis, and the production of a false passage all occurred to us. Also the effect of the immediate hemorrhagic reaction that must take place. We expected that this would, in a large percentage of cases, produce a temporary reactionary edema and were cognizant of the possibility of late cicatricial contraction. The effect of a permanently destroyed sphincteric action on digestion and the possibility of such an outlet being conducive to a future ascending cholangeitis was also considered.

With these possibilities in mind, we carried out a series of operations upon the biliary system of large dogs. We found it difficult to reproduce the method we had thought suited to the average human with a pathologic biliary system and indications for common duct exploration. The dog does not tolerate easily an external tube in the common duct as should invariably be used after exploration in man. Although possible to arrange such drainage in the animal, it was felt unjustifiable due to the restraining mechanism required. When the common duct was explored and sutured as carefully as possible with fine silk, we had a high mortality from bile peritonitis, a well-known clinical fact. It was possible to produce some moderately enlarged common ducts by a previous cholecystectomy. We were able to dilate a few papillae from an opening in the duct and have the animal survive any bile leakage without external drainage. We found it quite safe to perform this dilatation transduodenally, since the opening in the duodenum could be accurately closed. Inasmuch as most of our patients were having the dilatation carried out through an opening in the duct, we questioned any conclusions that might be drawn from experimental, transduodenal manipulations. On the whole, we believed that the dog with his thin, variable ducts could not easily be used for reliable comparative data with the usual pathologic conditions

met with in man, and for these reasons discontinued these experiments; proving only that hemorrhagic reaction of a mild degree occurred after dilatation, as would be expected, and that while the animals lived there was no indication of cicatricial constriction. These experiments have been more thoroughly and adequately repeated by Zollinger, Branch and Bailey.[5, 6] These investigators have drawn conclusions from their researches which we believe to be at some variance with our clinical experience. For this reason we wish to set forth in some detail the results obtained by the method in our hospital. It is of interest to know that 39 members of the visiting staff and 33 of the resident staff participated in these operations. The data include the patients

TABLE I

BILIARY TRACT OPERATIONS

M. G. H., Oct. 1, 1930–Oct. 1, 1935 (Previously Reported)

	No. of Cases		No. of Deaths		Mortality Percentage	
Cholecystostomy	82		12		14.5	
Cholecystectomy	751		22		2.9	
Cholecystectomy with common duct exploration and dilatation of sphincter*	231	395	9	17	3.9	4.4
Cholecystectomy with common duct exploration and sphincter not dilated*	164		8		4.9	
Totals (5 years)	1,228		51		4.2	

* Under the heading "Cholecystectomy with common duct exploration" are included several cases of secondary choledochostomy, the gallbladder having been removed at a previous operation.

M. G. H., Oct. 1, 1935–Oct. 1, 1939

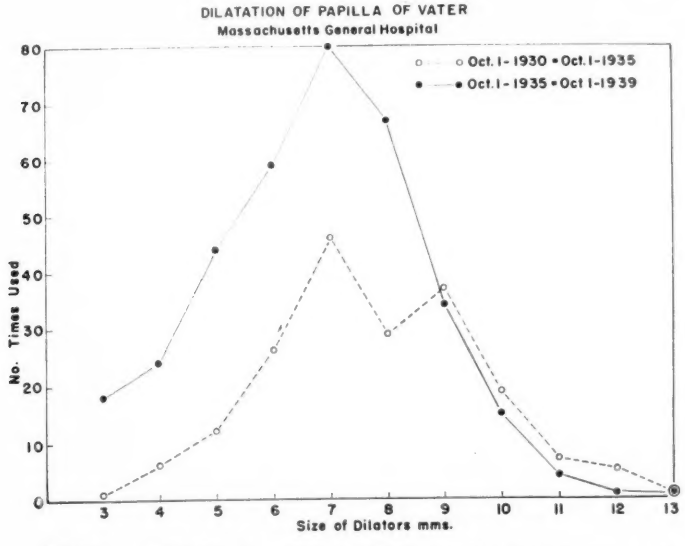
	No. of Cases		No. of Deaths		Mortality Percentage	
Cholecystostomy	48		4		8.33	
Cholecystectomy	432		7		1.62	
Exploration of the common duct with dilatation of the papilla of Vater	330	380	13	16	3.93	4.21
Exploration of the common duct without dilatation of the papilla of Vater	50		3		6.00	
Totals (4 years)	860		27		3.25	

M. G. H., Oct. 1, 1930–Oct. 1, 1939

	No. of Cases		No. of Deaths		Mortality Percentage	
Cholecystostomy	130		16		12.30	
Cholecystectomy	1,183		29		2.45	
Exploration of the common duct with dilatation of the papilla of Vater	561	775	22	33	3.92	4.25
Exploration of the common duct without dilatation of the papilla of Vater	214		11		5.14	
Totals (9 years)	2,088		78		3.73	

operated upon in the Baker Memorial and the Massachusetts General Hospitals.

From October 1, 1930, to October 1, 1935, 1,228 patients in our hospital were operated upon for disease of the extrahepatic biliary system. Of these, 395 had exploration of the common bile duct; 231 had instrumentation of the papilla, with an average dilatation of 7 Mm.; 164 had nothing more done than the removal of existing calculi and the determination that the papilla was patent. In the four-year period, from October 1, 1935, to October 1, 1939, 860 additional patients were subjected to operations upon the biliary tract. Of these, 380 had common duct exploration; in this group 330 had



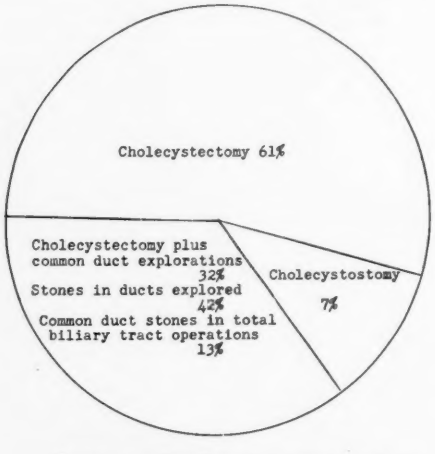
GRAPH 1.—Showing the degree of dilatation and the frequency of its employment during the two periods October 1, 1930–October 1, 1935, and October 1, 1935–October 1, 1939.

their papillae dilated while only 50 had a simple exploration. It is, therefore, apparent that more of our staff have become convinced of the safety and rationale of routine gentle, gradual dilatation of the duct outlet.

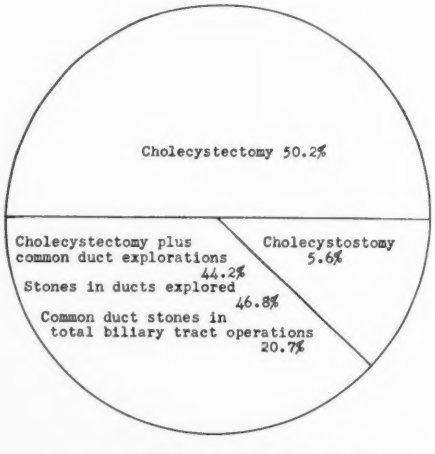
In Table I, it is seen that dilatation carried out in the manner that we have suggested does not increase the mortality. In fact, it would seem that this procedure was attended by less risk than exploration alone. This may not be true, since a patient doing poorly on the table may have caused the operator to omit instrumentation. On the other hand, in a careful analysis of all complications, we are impressed with the greater number of infections, prolonged biliary drainage, and longer hospitalizations in those patients who had no dilatation of their papillae. It would seem that at least one of Bakes' claims may have been justified, *i.e.*, dilatation enhances the flow of bile into the duodenum.

In Graph 1, we see that the amount of dilatation has varied greatly; obviously it has been dependent on the size of the duct and the size of the stones

found either in the gallbladder or the ducts. No attempt should ever be made to stretch the size of the duct itself, and we feel sure that this has not been done in our cases. It is unfortunate that the Bakeš dilators have too frequently been referred to as common duct dilators. The peak of the curve is definitely 7 Mm., from 6 to 8 Mm. having been used on more than two-thirds of all the cases. In the smaller sizes one may well wonder whether any dilatation could have taken place since the normal papilla will admit the 3 Mm. dilator with very little resistance. We do, however, encounter some papillae associated with small thickened ducts that do not permit the use of the medium sized dilators. On the other hand, we have some very large ducts with very large stones present. One can with ease determine the size of the hepatic ducts and assume that a stone may be tucked away within the ducts above the portal fissure. It is in such a dilated biliary tree that one is justified



GRAPH 2.—Showing the nature and percentage of biliary tract operations performed at the Massachusetts General Hospital, during the period October 1, 1930–October 1, 1935.



GRAPH 3.—Showing the nature and percentage of biliary tract operations performed at the Massachusetts General Hospital, during the period October 1, 1935–October 1, 1939.

in gradually stretching the papilla to the size of the hepatic duct. This occasionally requires the use of the larger sized dilators.

There has been a gradual increase in the percentage of ducts explored and stones found as shown in the comparative Graphs 2 and 3. The incidence of stones found in all biliary tract operations might be indicative of many overlooked stones in the former series and should have resulted in a very large number of patients returning for further surgery. As a matter of fact, the proportional increase is far greater than the incidence of unrelieved patients. We are inclined to attribute this discrepancy to a better system of immediate postoperative notes. We have not included cases that have been recorded as having had "mud" or "detritus" in the ducts with those having had stones. Also, there may be some variation in the type of patient coming to a general hospital clinic in comparison to a selected group. For instance, in our own personal series of 266 biliary tract operations during this period, 159, or 59.7

per cent, had duct explorations, in whom stones were found in 98 instances. This represents 61.6 per cent of the ducts explored, or 36.8 per cent of all cases operated upon for biliary tract disease.

The data in Table I indicate a more radical tendency as regards cholecystectomy rather than cholecystostomy, but we still feel that the latter operation is justifiable under certain circumstances, particularly in the aged and very ill patient. One must also admit that exploration of the ducts superimposed on cholecystectomy adds to the risk. It must be borne in mind, however, that the indications for common duct exploration are clear-cut and definite; also that these patients, on the whole, represent poorer risks on the basis of their pathology alone.

TABLE II

CAUSES OF DEATH IN COMMON DUCT EXPLORATION

M. G. H., Oct. 1, 1930–Oct. 1, 1939

	561 Dilated Cases	214 Nondilated Cases
Pneumonia	5	1
General peritonitis	3	3
Bile peritonitis	4	0
Hemorrhage	2	3
Bilateral pulmonary atelectasis*	3	0
Cardiac failure	3	1
Pulmonary emboli	1	2
Acute pancreatitis	1	0
Subdiaphragmatic abscess	0	1
Totals	22	11

* One death on operating table.

A careful comparative analysis of the complications following exploration of the ducts with and without dilatation of the papilla of Vater has been made. The fatal postoperative complications are summarized in Table II. There is not enough difference in the mortality percentage in the two groups to warrant argument, although there is a constant increase of over 1 per cent in those patients who did not have instrumentation of the papilla. It would seem that pulmonary complications were more frequent in those patients who had dilators passed through the duct outlet. This may be a coincidence but one must accept the fact that the added time consumed may be of significance. Also, there were four deaths from bile peritonitis in the group who had dilatation and none in those not dilated. This brings up points of detail of technic which are important even if it bears no real relationship to instrumentation of the papilla. These will be more completely discussed in a subsequent publication. Briefly, it means that the duct should never be sutured without adequate drainage to the outside. We believe that this should be accomplished by means of a tube sutured into the duct as well as drains placed in the most dependent area of this region. It is of utmost importance to be sure that the tube is draining bile before the abdomen is closed. Also, if there

is profuse bile drainage into the dressing or signs of bile peritonitis and little or no bile is coming through the tube, then the patient should be reoperated upon and the mechanical faults of the drainage corrected. The earlier this is recognized and remedied, the better the convalescence. It is pleasing to note that deaths from hemorrhage in jaundiced patients will probably not be recorded in the future, since the dramatic advent of vitamin K has eliminated this hazard.

TABLE III

POSTOPERATIVE HOSPITAL DAYS (NONFATAL COMPLICATIONS)

Papilla	561 Dilated	214 Not Dilated
Discharged by the eighteenth day	402, or 71.6%	109, or 50.9%
Remained in the hospital longer than 20 days	90	60
Private cases with no surgical reason for delay	29	6

TABLE IV

REASON FOR PROLONGED HOSPITALIZATION

Papilla	Dilated	Not Dilated
Wound sepsis	29	18
Pulmonary	9	2
Prolonged biliary drainage	4	27
Bile peritonitis	4	1
Study for other diseases	4	
Dehiscence	3	1
Miscellaneous	8	5
Totals	61	54
Per cent of total	10.9	25.7

The nonfatal complications are recorded in Tables III and IV. Based on the number of postoperative hospital days necessary, it is obvious that the patients who have instrumentation of the papilla have a shorter convalescence. The most striking difference is the greater number of patients who have prolonged drainage of bile to the outside in the nondilated group. This would indicate that instrumentation enhanced the flow of bile through the papilla. Table V further confirms this evidence.

TABLE V

PROLONGED BILIARY DRAINAGE

Papilla	561 Dilated	214 Not Dilated
Prolonged drainage	4	27
Discharged draining bile	4	18
Reoperated cases	4	8

It is apparent that many of the theoretic objections to instrumentation of the papilla have not been substantiated; also that some of the complications most feared have occurred rarely if at all. There has been no death or serious illness from acute ascending infection in our group, although two cases of gas bacillus infection were reported by Lahey.[7] There has been only one case of

duodenal reflux and this occurred early in the series, clearing up spontaneously in 21 days. This, we believe, may have been due to the only false passage recorded but we cannot be sure of the exact chain of circumstances.

Duodenal reflux occurred in two cases reported by Davis[8] in an earlier series from our hospital. These patients had very large stones, long impacted in the papilla, and will be discussed later under destroyed sphincteric action. One case developed acute pancreatitis, with fatal outcome. Since many of these instrumentations were undertaken through areas of thickening in the head of the pancreas, it is surprising that more of these did not develop a fulminating, acute flare of inflammation.

In the complications that come after the immediate convalescence is passed, we are equally surprised that most of our dreaded sequelae have failed to develop. The possibility of the effects of destroyed sphincteric action has been stressed. It is obvious from our experimental data, as well as those of others, that the sphincter is not destroyed when dilatation is carried to or just under the size of the average duct. Also, it must be borne in mind that the peak of dilatation has been within physiologic limits in the majority of our patients. There have been, however, enough individuals with very large ducts, having the papilla dilated to 8 Mm. or more in our group, to warrant a guess that occasionally the sphincteric action may have been destroyed. There have also been some cases who had stones of 1 cm. or more in diameter impacted in the duct ampulla for some time prior to operation. In these patients, transduodenal exploration was sometimes necessary and the sphincter actually incised in order to remove the stone. In none of these cases was there any evidence that such a practice was conducive to cholangeitis or serious digestive disturbances. It seems apparent that one could not destroy the sphincteric action of the papilla in the average case. We believe, however, that the loss of such action may not be too important to the health of the individual. The emphasis should be placed on the establishment of free bile drainage into the intestinal tract in the most normal manner consistent with the existing pathology. Since the duct runs obliquely through the duodenal wall in a longitudinal direction and there is a definite mucosal overhang to its outlet, there is obviously less danger of ascending infection in such a duct without a sphincter than there would be from the usual surgical anastomosis between the duct and the bowel.

TABLE VI

SECONDARY COMMON DUCT EXPLORATION

Papilla	561 Dilated	214 Not Dilated
Secondary operations:	8, or 1.42%	11, or 5.14%
For stone	4, or 0.71%	9, or 4.21%
For cholangeitis	1	0
For pancreatitis	1	1
For biliary cirrhosis	1	0
For cancer of the pancreas	1	0
For stricture	0	1

Late cicatricial contraction of the papilla following instrumentation has not occurred. We have been fortunate enough to reoperate on a few of these patients (Table VI). In four of these, the secondary operation was performed for stone, and in none was there any evidence of constriction of the previously dilated outlet. In two instances at least, the same size dilators that had been employed at the previous operations passed through the papilla. In the others, the papilla was instrumentated with greater ease than at the original procedure. The reoperations for cholangeitis and biliary cirrhosis were for preexisting conditions. This was probably true of the case of carcinoma of the pancreas. The one case of acute pancreatitis apparently had no bearing on the previous operation.

In the nine secondary operations for stone occurring in those patients who did not have the papilla dilated, it is fair to say that convalescence was good, and usually there was no return of symptoms after the stones were removed, even if the papilla was not instrumentated at this second procedure.

There are some interesting follow-up data on patients who have had symptoms after operation but have not been reoperated upon. There were ten patients in the nondilated group who continued to have attacks of biliary colic after common duct exploration, with removal of stones. One of these became symptom-free after an attack of colic and jaundice occurring four weeks after operation and has remained well for seven years. The other nine cases continued to have symptoms for as long as they were followed: four of them from one and one-half to four years; five from one to six months. Most of these were advised to have a second operation but either refused or went elsewhere to have it done. There was one patient who had instrumentation of the papilla with removal of stones from the ducts, who returned at the end of two months with the story of having had four severe attacks of biliary colic similar to the attacks he had had prior to operation. He reported at intervals of six months and three years that he had been symptom-free since his first postoperative visit. It is obvious to us all that patients may pass a stone from the common duct following cholecystectomy with or without common duct exploration. Unfortunately, a good many of the overlooked stones must be removed at a subsequent operation. It is our belief that many more stones will pass the carefully dilated papilla than the normal one. Our study of these records would seem to support such a viewpoint.

SUMMARY AND CONCLUSIONS

(1) Comparative data have been presented on groups of patients with biliary tract disease who have been subjected to common duct exploration—with and without instrumentation of the papilla of Vater.

(2) It appears that careful, gradual dilatation of the papilla to a size less than the diameter of the common bile duct is a safe procedure.

(3) There were more postoperative pulmonary complications in the group that had had dilatation of the papilla.

(4) Fatal bile peritonitis also occurred in four of those patients who had

dilatation, while none occurred in the nondilated group. We believe the technical difficulties of drainage accounting for these deaths have been corrected.

(5) There was a lower percentage of mortality in those patients who had dilatation of the papilla. This is not marked and we admit that it may not be significant.

(6) The nonfatal complications were greater in those patients who did not have instrumentation of their papillae. This was particularly evident as regards prolonged external bile drainage, increase in number of hospital days, and necessary secondary operations.

(7) Serious ascending infection, either late or early, did not follow instrumentation of the papilla of Vater in our cases.

(8) Duodenal reflux occurred in only one instrumented patient and this cleared up spontaneously.

(9) Late cicatricial constriction of the dilated papilla has not occurred.

(10) We doubt the permanence of the dilatation in the average case. In very large ducts with dilatation carried to 1 cm. the sphincteric action may be lost. Under these circumstances, it does not seem to have interfered with the health of the patient.

REFERENCES

[1] Allen, A. W., and Wallace, R. H.: Technique of Operation on the Common Bile Duct. Am. Jour. Surg., **28,** 533–561, 1935.

[2] Allen, A. W.: The Diagnosis and Treatment of Stones in the Common Bile Duct. Surg., Gynec. and Obstet., **62,** 347–357, 1936.

[3] Cheever, David: Instrumental Dilatation of the Papilla of Vater and the Dislodgment of Calculi by Retrograde Irrigation—A Contribution to the Surgery of the Bile Passages. Arch. Surg., **18,** 1069–1077, 1929.

[4] Bakeš, J.: On the Drainage-Less Surgery of the Bile Passages and on the Methodical Dilatation of the Papilla. Zentralbl. f. Chir., **55,** No. 30, 1858–1868, 1928.

[5] Zollinger, R., Branch, C., and Bailey, O.: Instrumental Dilatation of the Papilla of Vater. Surg., Gynec. and Obstet., **66,** 100–104, 1938.

[6] Branch, C., Bailey, O., and Zollinger, R.: Consequences of Instrumental Dilatation of the Papilla of Vater. Arch. Surg., **38,** 358–371, 1939.

[7] Lahey, Frank H.: Stones in the Common and Hepatic Ducts. New England Jour. Med., **213,** 1275, December 26, 1935.

[8] Davis, L.: Reflux of Duodenal Contents Through the Bile Duct. New England Jour. Med., **200,** 313, February, 1929.

SOLITARY CYSTS OF THE SPLEEN *

FOY ROBERSON, M.D.
DURHAM, N. C.

THE SUBJECT of this communication has a twofold purpose: First, to put on record before this Society two more cases of this comparatively rare condition; also, to call your attention to some of the rapidly changing thought in record to surgery of the spleen. The two cases herein reported were seen during 1937; the first was of the hemorrhagic type, and was operated upon by one of my colleagues, and will not be reported in detail. The second was operated upon by myself, and was of the serous or lymphatic type, being a definite, true, solitary cyst of the spleen. This case will be reviewed somewhat in detail.

Solitary cysts of the spleen should be classed as: (1) Hydatid. (2) Hemorrhagic. (3) Serous or lymphatic. The cause of hydatid cyst is definitely known and the diagnosis can be made and appropriate treatment instituted.

Hemorrhagic cyst of the spleen is due to hemorrhage either under the capsule or into its substance. The cause of the hemorrhage may be traumatic or spontaneous. The diagnosis and treatment in this type do not usually present difficulties, although the cause of the hemorrhage may not always be clear. The contents of such cysts are bloody and the lining wall in the hemorrhagic type is made up of fibrous tissue and has no epithelial lining.

The third type of solitary cyst, serous or lymphatic, is also a rather rare condition. Its contents are serous or lymphatic, which coagulate upon standing, and the wall of the cyst has an epithelial lining. To give you an idea of the rarity of this condition the Mayo Clinic, over a period of 36 years, from 1904 to 1934, reported 646 splenectomies, only two of which were recorded as cysts of the hemorrhagic type, and none of the lymphatic type.

Howald,[1] in 1926, was able to find records of 73 in the literature, of the type concerned in this group. Fowler[2] has ascribed the serous or lymphatic cyst to trauma, peritoneal inclusion, dilatation of the splenic sinuses, and degeneration due to arterial insufficiency in infarcts or tumors. So far as I know, there is no classic train of signs and symptoms by which these cysts may be diagnosed. They may, by accident, be found by the patient feeling an enlargement in the upper left quadrant of the abdomen, or in the course of a routine diagnostic survey of the patient. A study of cases reported will reveal the fact that the signs and symptoms usually differ quite widely in individual cases and are often misleading as will be seen in my own, as herein reported. There is no typical blood picture.

Case Report.—My patient had been variously diagnosed as appendicitis, visceroptosis, and renal infection. There were good reasons for each of these diagnoses. She was operated upon, January 12, 1938. However, she had been under the treatment of two or

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

three other physicians as far back as 1935. There was nothing significant in the family or the patient's history. She was a very intelligent young woman, age 23, a proofreader by profession. Her story was that she gradually became weak, lost weight, had indigestion accompanied by nausea, acne developed over the face, she developed low back pain and also symptoms suggestive of appendicitis, and became moderately anemic, apparently of a secondary type. Her ailments became so exaggerated that she found herself losing time from her work, necessitating rather frequent vacations. She would improve during rest periods but would relapse into the same condition after returning to work. It was during the course of a general diagnostic survey that the tumor was felt in upper left quadrant, and roentgenologic examination revealed an enlarged spleen; the stomach was pushed downward to the right; left kidney downward; and there was more or less general visceroptosis and urinary disturbances. The exact nature of the enlarged spleen, of course, could not be determined. However, it having followed shortly after the other case referred to, namely, that which proved to be a hemorrhagic cyst, we suspected a cyst of the spleen. Operation was not advised, however, until after the patient had been given a series of roentgen ray treatments, which did not afford relief; finally, operation was decided upon, at which a cystic spleen was revealed. A splenectomy was performed.

Pathologic Examination.—Gross: Path. No. 121–86, Dr. Roberson: The specimen is a spleen, considerably enlarged, roughly measuring 9x11x17 cm., and weighing 1,350 Gm. The upper and lower poles show grossly normal splenic tissue, but the greater part (central) is occupied by a large cyst, containing clear, straw-colored liquid, which coagulated on the standing. The lining of the cyst is white and shows numerous trabeculae, flattened against it. Except at the poles, the wall of the cyst is rather thin, averaging 2 to 4 Mm. in thickness. The fluid from the cyst contains no parasites, and cultures for bacteria are negative. *Microscopic:* Sections from the upper and lower poles show splenic tissue of the usual structure. The wall of the cyst contains much dense, hyaline fibrous tissue and is lined by a single layer of flat cells, which are slightly swollen in places. *Pathologic Diagnosis:* Dr. Thomas H. Byrnes: Cyst of spleen; nonparasitic.

Postoperative and Subsequent Course.—The patient stood the operation satisfactorily; being quite frail and anemic, she was given a blood transfusion following the operation. She made a good operative recovery and eventually returned to her employment as a proofreader; however, she still found herself unable to continue at work, and the low back pain persisted. It was probably not connected with the splenic condition. Her general health improved but not as much as desired. She is now acting as an assistant in a dentist's office and is getting along fairly well. The acne on the face has practically disappeared, leaving some scarring, but she gives one the appearance of being older than she really is; she is now in her twenty-fifth year but her tissues are those of a person five or ten years older.

An interesting question is: What was the exciting cause of this condition which practically destroyed the spleen, and what effect upon the organism, as a whole, has the splenectomy had? In short, by removing the spleen we stopped the progress of the condition but we have not supplied what the loss of the spleen has entailed, which leads us to a brief discussion of the second idea as the purpose of this communication, namely, a discussion of recent developments in the knowledge and functions of the spleen.

Hanrahan and Vincent[3] discuss this subject and make the following comment: "During the past decade much advance has been made in the knowledge of the spleen. It should no longer be said that the function of the spleen is unknown. The advance in anatomy and physiology, combined with much more exact hematologic diagnostic technic and information regarding the blood disorders, has led to considerable revision of our conclusions regarding

the indications for, and results of, splenectomy in those disorders." For instance, in the Mayo series of 646 splenectomies, a good many were performed for pernicious anemia and thrombopenic purpura hemorrhagica. The knowledge gained following the work of Whipple[4] on the anemias in general, and the observations of Minot and Murphy on liver treatment in pernicious anemia, would probably in the light of present knowledge, eliminate many of these operations. The so-called splenic anemia group, which according to these workers should be classified as anemia with splenomegaly, also the group of conditions coming under the head of Banti's disease would probably show by modern hematalogic diagnostic technic, and would no doubt be amenable to medical treatment without resort to splenectomy.

This leaves the question of what ultimate effect splenectomy has on the organism, as a whole, unanswered; but, as further study of the functions of the spleen is resorted to and more knowledge gained, the answer to this interesting question will no doubt be forthcoming sometime in the near future.

REFERENCES

[1] Howald, R.: Frankfurter Ztschr. f. Path., München, **33**, 349, 1926.

[1a] Pohle, W.: Cysts of the Spleen with Special Consideration of a Case of Large Cyst of the Spleen in a Paratyphoid. Deutsch. Ztschr. f. Chir., **221**, 211–222, 1929.

[2] Fowler, R. H.: Lewis' Practice of Surgery, **6**, Chap. 15, p. 3. W. E. Prior. Co., Hagerstown, Md., 1929.

[3] Hanrahan and Vincent: Lewis' Practice of Surgery, **6**, Chap. 15, p. 1, W. F. Prior. Co., Hagerstown, Md., 1929.

[4] Whipple, A. O., Reeves, R. J., and Cobb, C. C.: Atypical Hemolytic Anemias with Splenomegaly in Children. Tr. Am. Surg. Assn., **46**, 60, 1928.

DISCUSSION.—DR. CHARLES GORDON HEYD (New York, N. Y.): I would like to report a brief history of a New York surgeon who, 30 years ago, had his spleen removed for rupture during the course of typhoid fever. About every ten years this gentleman has had a complete check-up and, so far as his physicians have been able to determine, there has not been a single deviation from the normal. It may, therefore, be said that whatever function the spleen serves, an individual is capable of leading a normal life without it.

DR. J. DEJ. PEMBERTON (Rochester, Minn.): I would like to have the statistics from the Mayo Clinic brought up to date. Since 1904, there have been approximately 800 cases in which splenectomy was performed in the Mayo Clinic, and of this number there were only four cases of cyst of the spleen, an incidence of 0.5 per cent. I agree with Doctor Roberson, therefore, that a solitary cyst of the spleen is a rare condition. In the four cases that we have observed, all the patients were young people, the ages ranging from seven to 30; three were females and one was a male. There was no history of associated trauma in any of the cases. One woman had recently given birth to a child. This is mentioned because childbirth has been considered by some as a possible etiologic factor.

DR. FOY ROBERSON (Durham, N. C., in closing): Doctor Heyd's report of the doctor who had the spleen removed is, I think, in keeping with the usual course of events in adult life after splenectomy. One might compare the function of the spleen with that of the thyroid gland, or probably other glands of internal secretion. After the individual has reached full development the internal secretion is not needed as it is in the growing child, or the lost function may be taken up by some other glands of internal secretion.

THE DIAGNOSIS AND TREATMENT OF ACUTE PANCREATITIS*

JOHN J. MORTON, M.D.,

AND

STANLEY WIDGER, M.D.

ROCHESTER, N. Y.

FROM THE DEPARTMENT OF SURGERY, THE UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE AND DENTISTRY, ROCHESTER, N. Y.

THE DIAGNOSIS of acute pancreatitis by ordinary clinical methods is notoriously difficult and unsatisfactory. Evidence of this from the University of Rochester Hospitals was obtained when the subject was reviewed for the State Medical Society,[1] in the spring of 1939.

Early in the year, before getting together our material, consultations were had with many surgical leaders regarding their impressions about this condition. Their experiences, with scarcely an exception, were practically identical with our own.

It became apparent that at least three different pathologic types of pancreatic inflammation should be considered in any report on the subject. The acute edematous type could be subdivided further into mild and relatively severe forms. The hemorrhagic, necrotic type gave a more gloomy outlook. The suppurative form or pancreatic abscess occupied an intermediate position. At the time of my study this differentiation of the types in our clinic was very sketchy. From the clinician's standpoint he was lucky even to have considered the possibility of pancreatitis, let alone the finer shades of varieties.

The clinical picture was a confusing one for the severe forms of the condition. The symptoms and signs alone could not serve to differentiate the severe type of pancreatic edema from the other varieties. Pain was present in 100 per cent of all forms. It was sudden, severe, agonizing, in most instances. Occasionally it radiated transversely across the epigastrium from right to left. Vomiting occurred in 75 per cent. It was not a reliable symptom because it failed to persist in some cases but became almost continuous in others. Jaundice was present in only one-third of our patients. The presence or absence of shock depended upon the time when the patient was first seen by the physician. About 20 per cent of these patients were very fat and over one-half of them were more obese than the average. The most important vital sign was the relative increase of the pulse rate compared to the temperature. Tenderness was the outstanding physical finding. It was present in all cases; spasm was noted in 50 per cent; distention in 38 per cent. The white blood count averaged 17,000—an important aid.

At this time, in our clinic none of the special tests for pancreatic dysfunc-

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

tion were being made. They were considered to be too unreliable to be of value. Consequently we had no data on blood or urinary diastase, blood lipase, or tryptic ferment studies. We did record an occasional high blood sugar; and an occasional glycosuria in these patients.

Cases of milder pancreatic disorder were seen and so diagnosed without benefit of special laboratory tests. Consequently, they were not included in the report because they lacked scientific verification.

The diagnosis of acute pancreatitis of some form could be postulated when an obese individual had a sudden severe epigastric pain. If this was accompanied by vomiting, shock, tenderness in the epigastrium verging to the left, absence of fever, a relatively rapid pulse and a high white blood count, it was quite likely to be correct. Increasing distention would tend to further substantiate the diagnosis; and tenderness in the left costovertebral angle would be of additional aid.

The diagnoses suggested by the many physicians who saw these patients were compared with those actually made as acute pancreatitis. On this basis, from symptoms and signs alone, the correct diagnosis was made in only 17 per cent. The most common errors were severe, acute biliary tract disease; ruptured ulcer; intestinal obstruction or mesenteric thrombosis; peritonitis; and coronary occlusion.

Following this poor showing of diagnostic acumen, we decided to make use of some special test for pancreatic dysfunction. The literature of the last ten years is full of references to various tests which are in use especially in foreign clinics.

In reviewing the tests for the measurement of pancreatic activity, we decided that the amylase test was the most constant and satisfactory. Consequently, we adopted Somogyi's[2] amylase method for use in our clinic. This test is carried out as follows: A starch solution containing 75 mg. of starch and 250 mg. of sodium chloride per 100 cc. is used as a substrate. The testing solution is made up of a 0.002 n solution of aqueous iodine in 2 per cent potassium iodide. Four cubic centimeters of the starch solution are placed in an ordinary test tube and immersed in a water bath at 40° C. While this is warming up 0.5 cc. portions of the iodine solution are added to several small (7 Mm.) test tubes. One cubic centimeter of the serum or plasma to be tested is then added to, and mixed with, the warm starch solution and the time noted. At intervals of two to five minutes, 0.5 cc. samples of the incubating mixture are withdrawn and added to one of the small test tubes containing the iodine solution. This is then viewed in transmitted light. As the hydrolysis of starch proceeds, the original blue color will change to deep purple, light purple and finally to the red-brown color of erythrodextrin. The end-point is the time at which a barely perceptible tint of purple can be seen in the red-brown solution. If the amylitic activity of the blood is high, the first specimen of the incubating mixture may be past the end-point when tested. If this occurs, one must either test a similar new set-up at more fre-

quent intervals or use serum diluted with 0.5 per cent sodium chloride, the latter method being preferable. In practice, the test is easy to do, and with some experience in the colors one can estimate the speed of the reaction and fewer sample tests will have to be made.

The results are calculated from the formula $AA \text{ (or D)} = \frac{K}{T \times V}$ where AA is the amylitic activity of the sample; K a constant usually about 1,600; T the time in minutes required to reach the end-point; and V the volume of serum used. Normal values range between 70 and 200.

The concept of amylitic activity expressed in this way is an outgrowth of the use of copper reduction methods in sugar determination. By these methods

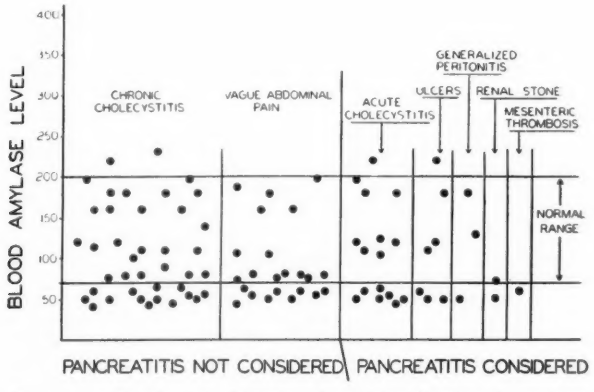


CHART 1.—Showing the blood amylase determinations in various types of epigastric disease, undertaken in order to control its value.

the sugar content of the serum was determined, after which another sample of serum is incubated with a starch solution under standard conditions and the "sugar" content of the starch serum mixture determined. The difference, then, represented the increased copper reduction resulting from the partial hydrolysis of starch and was expressed in terms of glucose. A value, for example, of 140 then means that, under standard conditions, 100 cc. of the plasma would produce starch cleavage products having the same copper reduction as 140 mg. of glucose. In Somogyi's method the glucose is not determined at all, but the results are expressed in terms of copper reduction assumed to be glucose formation. This apparent paradox is explained by the use of the constant K. In the correlation of a large number of determinations by copper reduction and the time methods, it was found that the value for K held under the conditions described. In other words, the same results will be obtained with the use of either the sugar reduction or the starch-iodine method. We have done a few determinations by both methods and find the correlation satisfactory.

Since June, 1939, we have used the amylase test in various types of cases where abdominal pain was a symptom. The distribution of values obtained is shown in Chart 1. In 40 cases of chronic cholecystitis, referred into the hospital for elective operation, two were slightly higher, and 14 were slightly lower, than normal. Of 23 patients with vague abdominal pain, none gave readings higher than normal. Of 29 cases in which pancreatitis was considered but not diagnosed, two were slightly higher and ten lower than normal. These 29 included cases of acute cholecystitis, ulcers, generalized peritonitis, renal stone and mesenteric thrombosis.

Of 12 cases showing significant elevations of blood amylase, nine came

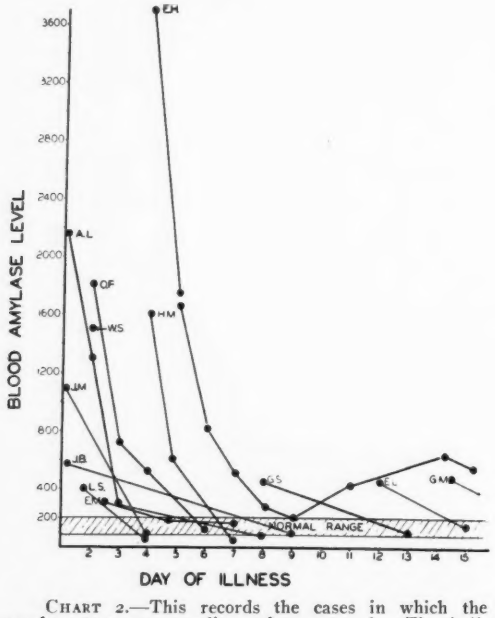


CHART 2.—This records the cases in which the amylase test gave readings above normal. The individual cases, as indicated by initials, are discussed in the text.

to operation (Chart 2). Seven showed evidence of pancreatitis; and in those with higher amylase levels the edema was marked. Of the other two operative cases, L. S. (amylase 400) had a common duct stone with marked edema over the common duct with the pancreas normal to palpation. G. M. (amylase 430) was shown to have extensive carcinoma in the right upper quadrant with almost complete duodenal obstruction and the pancreas was not palpated. A. L. was operated upon with the preoperative diagnosis of acute cholecystitis. In J. M. operation was performed for suspected perforated ulcer. Both had edematous pancreases at operation. Preoperative blood amylase had not been estimated in either case because the diagnosis was not suspected. In both, the amylase level was found to be high after operation. In three cases with elevated amylase readings, not coming to surgery, we were able to fol-

low two. O. F. presented the clinical picture of the disease and his readings gradually fell to normal in six days. He returned to the Emergency Department two weeks later with moderate recurrence of pain. At that time he showed an amylase determination of 270 but declined to remain for treatment. E. M. can be regarded as a questionable case. He was an alcoholic with diminished liver and kidney function with moderate upper abdominal pain. This cleared in about five days, during which time he was moderately ill. W. S. was discharged on the day following admission.

CASE REPORTS OF 12 PATIENTS SHOWING SIGNIFICANT ELEVATIONS OF BLOOD AMYLASE

Case 1.—Hosp. No. 145426: E. H., female, age 26, was admitted to the Rochester Municipal Hospital, May 13, 1939, complaining of epigastric pain. This began six days before admission with a transient attack which subsided. The pain returned four days before admission with radiation to both shoulders, nausea and vomiting. She had been unable to retain food for three days. On admission, the pain was localized in the epigastrium. There was no history of previous episodes. The patient had had nocturia of two times and some urgency but no burning for several years. Examination showed a temperature of 37.4° C., pulse 84, respirations 22. She appeared pale, acutely ill and dehydrated. Respiratory movements were limited. The breath sounds were slightly suppressed at the right base. The abdomen was scaphoid with localized epigastric tenderness and voluntary spasm with rebound pain throughout. The gallbladder was not palpable. Murphy's sign was equivocal. Left costovertebral angle tenderness was present. The white count was 18,800, and the urine showed a two plus acetone and many white cells in the catheterized specimen. The diagnosis rested between a low grade pancreatitis and chronic pyelitis. She was given parenteral fluids and mild sedation.

On the following day the epigastric pain was more severe and moderate distention was present. The temperature rose to 38.8° C. and the pulse to 120. The blood amylase was 3,700; and the icteric index 18. Conservative treatment was continued and included a blood transfusion. On the third day, jaundice was evident but the patient felt better. The blood amylase was 800; and the icteric index 48. On the fourth day the icteric index rose to 83 while the amylase dropped to 80. The temperature, which had fallen, was again elevated.

Operation.—The abdomen contained a large amount of clear yellow fluid. The head of the pancreas was swollen and indurated and small fat necroses were present. The gallbladder was distended and contained many stones. No common duct stone was palpable. The gallbladder was drained and a cigarette drain inserted into the lesser peritoneal cavity. There was bleeding from the wound which was controlled with transfusions and vitamin K. Her course was stormy. There was no drainage from the cholecystostomy tube. She was discharged from the hospital on the twenty-sixth postoperative day, and when last seen, four months after discharge, her only complaint was easy fatigability. *Postoperative Diagnosis:* Acute edematous pancreatitis with fat necrosis; cholelithiasis.

Case 2.—Hosp. No. 155656; H. M., female, age 60, was admitted to the Strong Memorial Hospital, July 28, 1939, complaining of upper abdominal pain of four days' duration. This was of sudden onset, radiated to the back, doubled her up, and was followed by nausea, and vomiting without relief. The pain lessened but was constantly present until the time of admission. A history of intolerance to fatty foods was obtained. Examination showed a temperature 38° C., pulse 104, respirations 26, blood pressure 150/90. The patient appeared acutely ill. There was lower chest pain with coughing. The abdomen was slightly distended. There was tenderness in the epigastrium and right

upper quadrant, where slight spasm was present. The white blood count 6,800. There was bile in the urine. Icteric index 30. Blood amylase 1,600. The patient was considered to have an acute pancreatitis, probably on the basis of a common duct stone. Operation was advised but refused. Daily deep roentgenotherapy of 75 r was given for a period of six days. The amylase fell to 40. The patient improved but continued to have epigastric distress. Intravenous cholecystogram showed a small area of decreased density in the gallbladder and a dilated common duct. Gastro-intestinal series and barium enema were negative. Because of continued discomfort the patient consented to operation after 19 days.

Operation.—The gallbladder contained sand and a single stone was removed. The head of the pancreas was the size of an orange, rubbery and lobulated. The common duct contained no stones. The postoperative course was febrile for three days after which improvement was slow and the patient was discharged on the nineteenth postoperative day. When last seen, six weeks after operation, her only complaint was slight tenderness at the site of the stab wound. *Postoperative Diagnosis:* Subacute edematous pancreatitis; cholelithiasis.

Case 3.—Hosp. No. 128221: A. L., male, age 53, was admitted to the Strong Memorial Hospital, May 24, 1939, complaining of severe upper abdominal pain, more marked on the right side. For two weeks he had had general malaise, upper abdominal soreness, anorexia and headache. The pain became quite severe the day of admission, and the patient felt faint. For the past two years he had had minor attacks of right upper quadrant soreness and nausea relieved by vomiting. In addition, he had two rather severe episodes less painful than the present one. Examination showed temperature 39.4° C., pulse 124, respirations 24. Blood pressure 120/80. The patient appeared acutely ill. General examination was negative. There was no jaundice. The abdomen showed marked tenderness and spasm in the right upper quadrant. The white blood count was 21,100. Blood amylase determination was not done. Diagnosis of acute cholecystitis was made and immediate operation performed.

Operation.—The pancreas and surrounding retroperitoneal tissues were markedly edematous. The gallbladder was tense but smooth. Cholecystectomy was performed. Blood taken immediately after operation showed an amylitic activity of 2,160. The temperature gradually returned to normal on the fifth postoperative day. The patient was given small doses of deep roentgenotherapy on the second and third postoperative days. The blood amylasé was 400 on the second postoperative day and 90 on the fourth postoperative day. The patient was discharged on the twenty-second postoperative day, and when seen one month after discharge, he had no complaints referable to the abdomen. *Postoperative Diagnosis:* Acute edematous pancreatitis; cholecystitis.

Case 4.—Hosp. No. 133361: J. M., male, age 71, was admitted to the Rochester Municipal Hospital, June 6, 1939, complaining of severe abdominal pain of three hours' duration. This came on suddenly and radiated across the abdomen but not to the back, shoulder or arm. The patient was soon doubled up and developed a cold sweat. There were no previous attacks of abdominal pain save for a severe attack of "cramps" 25 years age. Examination showed a temperature of 36.5° C., pulse 60, respirations 18. Blood pressure 180/90. The patient appeared acutely ill. The skin was cold and moist. He was well preserved and there were no abnormalities of the cardiovascular system found. The abdomen showed tenderness and spasm in both upper quadrants. White blood count was 13,500; and an emergency electrocardiogram showed an interventricular conduction defect. He was considered to have either a perforating ulcer or a coronary occlusion. Three hours after admission the abdomen was board-like in both upper quadrants and operation was undertaken.

Operation.—The abdomen contained much bile-stained fluid. The pancreas was indurated, swollen to about five times normal size, and showed tiny areas of recent hemor-

rhage. Small areas of fat necrosis were present. The gallbladder was distended. No stones were palpable in the common duct. Blood amylase immediately after operation was 1,100. The postoperative course was stormy and the temperature remained elevated for two weeks, during which time the patient was dangerously ill. Deep roentgenotherapy of 50, 100 and 150 r was administered on the sixth, seventh and eighth postoperative days. The wound became infected, partially digested and the drainage fluid was shown to have an amylitic activity of 4,000. With aluminum paste, frequent irrigations, and constant suction it finally healed in. He was discharged from the hospital on the thirty-seventh postoperative day. When last seen ten weeks after discharge he was feeling well and had gained some 20 pounds in weight. *Postoperative Diagnosis:* Early, acute hemorrhagic pancreatitis with fat necrosis.

Case 5.—Hosp. No. 157056: W. S., female, age 37, was admitted to the Strong Memorial Hospital, September 13, 1939, complaining of severe abdominal pain. This began 48 hours before admission. It was most severe in the right upper quadrant and radiated to the back and right shoulder. There had been constant nausea and repeated vomiting. The pain was not relieved by a hypodermic of morphine given by her physician. For the past three years she had had gallbladder attacks, once with jaundice, and she avoided fatty foods. The pain had never been severe enough to require hospitalization before. Examination showed a temperature of 37.6° C., pulse 84, respirations 22. The patient was in acute distress. The skin showed no jaundice. The abdomen showed marked right upper quadrant tenderness and spasm, but elsewhere was soft. Murphy's sign was positive. The white blood count was 6,800; and the blood amylase 1,500. On the following day the pain had largely subsided, but there was residual right upper quadrant tenderness. The patient was discharged to her physician in Canada. *Clinical Diagnosis:* Acute edematous pancreatitis.

Case 6.—Hosp. No. 155800: O. F., male, age 37, was admitted to the Rochester Municipal Hospital, August 1, 1939, complaining of epigastric pain of one day's duration. This came on shortly after a hearty evening meal. Vomiting was induced with slight relief. He was able to sleep lightly. On the morning of admission he ate a light breakfast and had little pain until three hours later. Then the same pain returned of such severity that he stopped work. He called his physician, who gave codeine and morphine, without relief. Four days before admission he had a similar but transient attack with fever of 103° F. All his symptoms subsided without treatment. There was no history suggestive of gallbladder disease. Five years ago he had had pain after meals with relief by an ulcer regimen for a short time. On examination he was found to have a temperature of 40° C., pulse 96, respirations 20. Blood pressure 110/70. He was acutely ill. The skin was not jaundiced. The abdomen was scaphoid with epigastric tenderness and slight spasm. No fluid wave could be demonstrated. The white blood count was 17,800; icteric index 42; and blood amylase 1,800. The diagnosis rested between pancreatitis and a penetrating ulcer. He was given little by mouth and daily deep roentgenotherapy of 75 r for three days. After 24 hours the pain largely subsided. The temperature returned to normal in 36 hours. The blood amylase steadily fell to normal in five days. On the fifth day, the pain was practically gone, and a barium meal showed a normal stomach and duodenum. He insisted on discharge on the sixth day. A gastrointestinal series, ten days later, showed slight irritation near the duodenal cap. He returned two weeks after discharge with moderate epigastric pain. The temperature was 38.4° C., white blood count 9,000, and amylase 270. There was tenderness deep in the epigastrium, without spasm. He refused admission. When last seen, three weeks after discharge, he was having no pain and wished to be returned to the care of his physician. *Clinical Diagnosis:* Acute edematous pancreatitis.

Case 7.—Hosp. No. 157,882: G. S., female, age 69, was admitted to the hospital, complaining of epigastric pain and jaundice. There had been repeated attacks of right upper

quadrant pain with subscapular radiation for three months. On the day before admission she began having constant, severe epigastric pain. Examination showed an acutely ill, jaundiced patient with a temperature of 40° C. There was diffuse epigastric tenderness more marked on the right side. The white blood count was 7,500; icteric index 30; and blood amylase 450. The diagnosis of chronic cholecystitis with cholelithiasis, common duct stone, and secondary pancreatitis was made. This was confirmed at operation four days later, at which time her general condition was improved and the initial prothrombin time of 55 seconds reduced to 20 seconds with vitamin K. The blood amylase on the day of operation was 100 and remained within normal limits during her stormy convalescence.

Case 8.—Hosp. No. 57,189: J. B., female, age 52, was admitted to the hospital, complaining of high abdominal pain which also involved the left chest, shoulder and arm. This began suddenly the morning of admission, and was associated with nausea, vomiting and diarrhea. A similar previous attack, 18 months before, had been diagnosed possible angina pectoris. Her only cardiac symptom was exertional dyspnea. A cholecystostomy had been performed 18 years ago at another hospital. At the time of admission, left upper quadrant and epigastric tenderness was present. The white blood count was 10,500; blood amylase 540, and nine days later 80. She was discharged after an 11 days' stay during which time an oral cholecystogram showed a nonfunctioning gallbladder.

Case 9.—Hosp. No. 157,965: L. S., female, age 54, was admitted to the hospital, complaining of right upper quadrant pain radiating to the subscapular region. This was her third and most severe attack. Continuous nausea was present. She was acutely ill with a temperature of 40° C., pulse 120. There was upper abdominal tenderness, more marked on the right side. White blood count 7,400; icteric index 48, and amylase 400. On the second day the amylase was 60. At operation, on the fifth day, the gallbladder was found filled with stones. There was marked edema over the common duct which contained a stone at the ampulla. The pancreas was normal to palpation. Her convalescence was uneventful.

Case 10.—Hosp. No. 55,939: E. L., female, age 59, was admitted to the hospital complaining of attacks of pain between the shoulder blades and on the right side of the abdomen. She gave a gallbladder history of one year's duration, with much pain during the two weeks preceding admission when jaundice became apparent. At the time of admission she was in no distress. The skin was slightly icteric. The liver edge was palpable. The icteric index was 30; white cells 10,300. On the following day she was suddenly seized with right costal and subscapular pain. The blood amylase was 400. Cholecystectomy was performed and several small pieces of gravel removed from the common duct. The head of the pancreas contained several rubbery nodules. Her convalescence was uneventful. Three days after operation the blood amylase was 150.

Case 11.—Hosp. No. 157,530: G. M., male, age 63, was admitted to the hospital, complaining of a biliary fistula of six months' duration. It was learned from his surgeon that carcinoma of the pancreas or bile ducts was suspected at the time of operation, but no mass was palpable. Previous to admission here, he had had a heavy feeling in the abdomen following meals but no vomiting. Examination showed obvious weight loss, and slight anemia, but no jaundice. There was a firm mass in the right upper quadrant. A gastro-intestinal series showed almost complete duodenal obstruction. The icteric index was 12; amylase 400, and one week later was 80. At operation a hard tumor was found in the duodenum, and the right upper quadrant was infiltrated with carcinoma. A gastro-enterostomy was performed. The patient died four days later from Type 19 pneumonia. Autopsy was refused.

Case 12.—Hosp. No. 134, 723: E. M., male, age 33, was admitted to the hospital, complaining of upper abdominal pain beginning three days before admission and increas-

ing in severity. He was unable to retain food. He had been previously diagnosed as having cholecystitis, duodenal ulcer, renal stone, nephritis, and was a known alcoholic. The temperature was slightly elevated. The abdomen showed generalized tenderness without spasm and referred rebound pain to the epigastrium. White blood count 14,000 and 25,000; blood amylase 360; and icteric index 30. The urine contained albumin and a few white cells. The pain subsided. In three days the amylase was 100. He was shown to have a nonfunctioning gallbladder, dilated right ureter, and impaired liver and kidney function. He was discharged to be followed with conservative therapy.

It is claimed that the blood amylase test is given for only a transient period in the severe, hemorrhagic, necrotic forms of pancreatitis. We have not had sufficient experience to verify or deny this. If it be so it is unfortunate. The clinician certainly needs some assistance to arrive at the correct diagnosis in these individuals.

In a given case we make every effort to arrive at the diagnosis by a careful history and the ordinary methods of physical examination. Blood is taken for transfusion matching; for icteric index if indicated; and for the amylase test. If perforated ulcer is suspected, roentgenograms may demonstrate free air in the abdominal cavity. If obstruction is a possibility, a roentgenogram may show the offending loops. Coronary occlusion should give some changes in the blood pressure; or electrocardiograms should be helpful. If all these examinations reveal nothing significant, the amylase test may be helpful in arriving at the correct diagnosis. Abdominal paracentesis has been advocated[3] and may be of assistance. The fluid recovered by aspiration may be opalescent, bloody, bile tinged, or serous. We suggest that an amylase test on this fluid may be diagnostic. In cases where drainage of the pancreas for pancreatitis has been performed in our clinic, we have found that the fluid gives high amylase test values.

Treatment.—There is a wide difference of opinion as to the proper treatment for acute pancreatitis. Most surgeons agree, however, that acute pancreatic abscess should be drained. Drainage can be effected through the gastrocolic omentum, the gastrohepatic omentum, the foramen of Winslow or retroperitoneally in the lower flank.

The acute, fulminating, hemorrhagic, necrotic type has had a high mortality in the past from immediate operation. Some surgeons claim that they would not operate upon this form if they could be sure of their diagnosis. The fear of acute perforation of a viscus or strangulation of the bowel causes them to explore. The difficulty in diagnosis will undoubtedly remain and patients will continue to have explorations for these acute abdominal emergencies.

It would seem wise to take time to get these patients into the best possible condition before operation. Shock should be adequately treated and fluid balance restored. In the very ill patients, the most simple surgical treatment will be all that should be undertaken. If jaundice is present, drainage of the gallbladder or common duct may be employed to advantage. The pancreas should be disturbed as little as possible because it cannot be drained by split-

ting the capsule as formerly advocated. The organ is crisscrossed by connective tissue partitions so that it is made up of many separate chambers. Incision into it leads to hemorrhage, necrosis, and is damaging. The purpose of drainage is to establish sinuses and to wall-off the general peritoneal cavity from the extension of the secretions. The secretions are thus led out to the surface. Necrotic tissue can be extruded along these same drainage tracts. Large pieces of necrotic pancreatic tissue have been sequestrated in this manner. The drains should be placed against the surface of the pancreas after the peritoneum over it has been greatly spread apart or incised.

Comparative statistics from several clinics show that there is a decided advantage in mortality when operation is delayed instead of being carried out immediately. Nevertheless, there is a mortality from delayed surgical treatment which must be expected in any series. Some of our patients have been too ill for operation and could not be rallied sufficiently to make it possible. There will also be a mortality from missed perforations or strangulations if a waiting policy is adopted in these severe abdominal catastrophes. This must not be discounted.

In the milder forms of acute pancreatitis as represented by the edematous variety, the amylase test is the most useful. The surgeon can be fairly sure of his diagnosis. He can watch these patients to advantage, being guided by the amylase readings. The surgeon will be on the alert to detect the edematous pancreatic tissue which he might easily miss without a signpost. There is a tendency for this form of pancreatitis to subside in most instances. After the subsidence of the attack exploration of the common duct with drainage for some weeks is usually all that is necessary to cure this condition.[4]

We have been interested in the analogy between acute parotitis and acute edematous pancreatitis. The amylase test gives elevated readings in each of these conditions. It seemed to us that if the acute parotitis had such a remarkable response to small roentgen ray treatments,[5] the same might hold for the pancreas. Consequently, we have tried this treatment cautiously in several cases. The effect appears to be satisfactory. We have used 50 r and 100 r units measured in air through two portals for a total dosage of 250 r–450 r units. Dr. Andrew Dowdy has collaborated with us in this work. The effect is probably due to some chemical change in the body fluids. It is possible, however, that it may be due to temporary inhibition of the gland. Certainly, a small treatment over the salivary glands often causes diminution in secretion. This, in effect, puts the gland at rest. If so, it is good therapy for any infection. We believe that roentgenotherapy may shorten the attacks but we offer this only as a suggestion without adequate proof as yet.

REFERENCES

[1] Morton, J. J.: Acute Pancreatitis. New York State Jour. Med., **40**, 255–263, 1940.
[2] Somogyi, M.: Micromethods for the Estimation of Diastase. Jour. Biol. Chem., **125**, 399–414, 1938.

[3] Peterson, L.: Einige Worte über die Diagnose und Behandlung der Akuten Pankreas-Krankheiten. Zentralbl. f. Chir., **61**, 333–334, 1934.

[4] Cole, W. H.: Treatment of Acute Pancreatitis; Collective Review. Internat. Abst. Surg., **67**, 31–38, 1938.

[5] Robinson, J. M., and Spencer, J.: Roentgen Therapy of Acute Postoperative Parotitis. New England Jour. Med., **215**, 150–153, 1936.

DISCUSSION.—DR. ROY D. MCCLURE (Detroit, Mich.): It is interesting to note that the laboratory again has come to our aid in the early diagnosis of such an obscure condition as acute pancreatitis. As Doctor Morton pointed out, it is only by prompt, accurate diagnosis that one avoids the tragedy of overlooking perforations of the stomach or gallbladder, such as occurs when physical diagnosis alone is relied on. Doctor Morton did not mention discoloration of the subcutaneous tissue around the umbilicus or in the flank as a diagnostic sign in acute pancreatitis.

The value of the sign has recently been stressed by Dr. Laurence S. Fallis, of our Surgical Staff at the Henry Ford Hospital, in a published report of three cases (Fallis, L. S.: Cullen's Sign in Acute Pancreatitis. ANNALS OF SURGERY, **106**, 54–57, 1937.) A positive sign is represented by ecchymotic areas surrounding the umbilicus or in the flanks. When the discoloration is in the periumbilical region, the condition is known as Cullen's sign, because he was the first to report it, though his observations were confined to cases of ruptured ectopic gestation. Grey-Turner, in England, has described ecchymosis of the flanks in acute pancreatitis; thus the sign is known as Grey-Turner's sign when it is seen in the flanks. The phenomenon is due to extraperitoneal extravasation of the products of pancreatic necrosis. The spread may be limited to the flanks or may continue forward until it meets obstruction from the round ligament of the liver, when the tendency is for the fluid to track downward and pool in the subumbilical space. We have noted the sign on four occasions, twice in the flank and twice at the umbilicus. A strong light is necessary for its recognition and it is likely the sign is often unrecognized because in one of our cases it was not until the patient's abdomen was exposed to the strong operating room light that the discoloration was noted.

The speaker then showed a colored slide on the screen, which demonstrated the discoloration in the flanks—a positive Grey-Turner sign. This patient had been ill for a week with an obscure upper abdominal condition; and it was not until this sign appeared that the diagnosis was evident.

DR. IRVIN ABELL (Louisville, Ky.): Since the publication of my paper, which Doctor Morton quoted, we have had four additional cases of acute pancreatitis. The death rate still stands at nine, in a total now of 34. One clinical point in addition to those mentioned by the essayist which would possibly lead one to suspect the pancreas, is the history of gallbladder disease. This has been obtained in 28 of our 34 cases, 24 showing the presence of gallstones. Whether, as claimed by some, acute pancreatic edema is a clinical entity is open to dispute. My personal opinion is that edema, pancreatic necrosis, with or without hemorrhage, and pancreatic abscess are but parts of the same process, the diagnosis of each, as such, depending upon the time it is seen. In my paper I cited nine cases of pancreatic edema, all of which recovered; there were, however, three additional cases in which at the time of operation a diagnosis of pancreatic edema was made; all three died, one on the third, one on the sixth and one on the ninth day, autopsy, in all,

showing pancreatic necrosis. It is possible that the trauma of operation activated the process, but I am of the opinion that we were dealing with the first stage of what ultimately became a pancreatic necrosis. In ten cases, observed before 1925, an effort was made to drain the pancreas, going so far in two instances as to make incisions in the pancreas for this purpose. We had but one death in this group, and I think we were rather fortunate, in view of what we have since learned of the disease. Since 1925, such drainage as we have employed has been along the line laid out by the essayist in an effort to bring the ferment-laden fluids to the surface, rather than leave them in the abdomen.

I think all will agree that no operation upon the pancreas will lessen the tryptic digestion of the organ, and, hence, the less that is done to the pancreas itself, the better for the patient. We have had but two patients treated medically, in which the diagnosis was acute pancreatitis; one died and one recovered. No autopsy was permitted; consequently, I am unable to say whether the diagnosis was or was not correct. In patients subjected to operation, the diagnosis in 14 was acute pancreatitis, in 14, acute cholecystitis, and in the remaining six the diagnosis was divided between peptic ulcer and a high obstruction. The utilization of such a test as that mentioned by the essayist for amylase should produce a greater percentage of correct diagnoses; the amylase reaches an abnormal level in the blood within six to eight hours after the onset of an acute pancreatitis, and persists for from 60 to 80 hours at an abnormal level, following which time it gradually returns to normal. The blood lipase does not reach an abnormal level for three or four days after the onset of the acute condition, and persists for a longer period of time. The difficulties in reaching a correct diagnosis are such that I quite agree with the essayist in his statement that without exploration patients will be sacrificed who otherwise might be saved. There are certain indications which in the presence of an acute pancreatitis seem to me to demand operation: namely, an enlarged, palpable gallbladder; the presence of jaundice; the presence of fluid in the lesser omental cavity; and the detection of a mass at the site of the pancreas. I will go still further in my belief that drainage of the gallbladder is of benefit in the treatment of acute pancreatitis. Not infrequently, the gastrohepatic omentum is edematous and affords obstruction to the biliary tract; at times the enlargement of the pancreas offers the same difficulty, and drainage in such cases is helpful. Three patients in our series have previously recovered from an acute pancreatitis, and in all three, the diseased gallbladder may have been a factor in producing the second attack. Such an observation would indicate that following recovery from acute pancreatitis it is well at some subsequent date to correct any remaining pathology in the biliary tract.

Dr. George G. Finney (Baltimore, Md.): At the Union Memorial Hospital, in Baltimore, we have had 21 cases that would come under the classification of acute pancreatitis. At most we have diagnosed two correctly from a clinical standpoint, and I am not sure about them. Of course, pancreatitis had been mentioned, but I do not think the diagnosis was certain enough to base a surgical procedure on it. There were nine deaths, making a mortality of 42.8 per cent. Treatment has been quite uniform in all cases, namely, immediate operation, except for the usual administration of fluids, and general supportive measures that were indicated first. In all cases, the gallbladder has been drained and also the region of the pancreas, but, so far as I could tell, in no case was pancreatic tissue incised. In one of my own

cases, the patient had an acute hemorrhagic pancreatitis. Beginning on his fifteenth day postoperatively he was afebrile, and was allowed out of bed on his twenty-third day. On the evening of the twenty-fifth day, he suddenly died, and autopsy revealed he had had a massive pulmonary embolus. It was also shown that fully four-fifths of his pancreas was completely necrotic, with a retroperitoneal abscess some five by seven inches in size, and it seemed almost incredible that the patient could have been afebrile and apparently clinically well. In the light of these findings, it seemed questionable whether he was really benefited by the usual procedure of operation. Any help we can get in the diagnosis of these cases along the lines suggested by Doctor Morton should be of great benefit.

DR. JOHN J. MORTON (Rochester, N. Y., in closing): I want to thank the discussers for the very favorable reception of this paper. I know that it is a controversial subject and did not expect to get as much agreement as I have had. We hope we are going to be able to make our statistics compare favorably with others. The milder forms have not been included in my previous paper. The cases reported there were all severe. Some had fat necrosis of the pancreas and some died without any hemorrhage. We have postmortem examinations to prove these statements.

GRANULOSA CELL TUMOR OF THE OVARY *

REPORT OF A CASE

FRANK L. BARNES, M.D.,

AND

J. PEYTON BARNES, M.D.

HOUSTON, TEX.

THE RARITY of these tumors and their very unusual life history seem sufficient justification to report a single case. Their endocrinology is the most interesting factor in their history, though probably not the most important. However, the thought that a tumor can arise from the ashes of a burned-out ovary, as it were, and build itself up from these ashes until it assumes some of the complicated functions of the original ovary is most intriguing.

This tumor was first described by Rokitansky,[3] in 1855, and later by von Kahlden,[3] in 1895, but much confusion has generally existed as to its origin and its possible malignant nature.

The name "Granulosa cell tumor of the ovary" was proposed by von Werdt,[3] in 1914, and has been widely adopted. There are now about 300 or more granulosa cell tumors of the ovary on record, and there may be many unrecorded cases. Out of 400 solid tumors of the ovary examined at the Mayo Clinic,[1] 30 granulosa cell tumors were found.

The literature of this tumor has been written mainly in the last 15 years. In this country it has been contributed to largely by Novak, Dockerty and MacCarty, Telinde, Bland and Goldstein, Schattenberg and Harris, and many others. In 1937, Pratt[3] made a complete review of the literature up to that date, and reference is freely made here to his report. It was the intention of this paper "to correlate the clinical and histologic pictures of this tumor and undertake to show that it can, in most cases, be diagnosed before operation." This seems a very important objective, since uterine bleeding may result from other types of ovarian, as well as uterine disease. We are all "cancer minded," and any lesion, producing bleeding out of time, is of utmost interest.

No age, it seems, is exempt from the development of these tumors. Crossen and Crossen[2] point out that the "islands of embryonic sex cells or 'cell rests' may, at any age, begin to grow and function, causing symptoms of excessive ovarian activity. In children, the excess estrin secreted by these tumors causes precocious puberty, the child maturing sexually at an early age. Menstruation may appear at two or three years of age, with secondary sex characteristics, such as enlargement of the breasts and the appearance of pubic hair.

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

The mental age and activities of the child are not in advance of its years. In cases in which the tumor does not begin until adult life, when the woman is already menstruating, the symptoms are frequently masked. There may be an increase in the amount of menstrual flow, but nothing else to indicate the presence of such a tumor. Occasionally, there are periods of amenorrhea interspersed with periods of menorrhagia. After the menopause, between 40 and 50 or 50 and 60 years, the tumor is likely to cause return of menstruation or prolongation of it, if the tumor becomes active before menstruation ceases entirely."

Novak[4] has pointed out "that the cells of the granulosa cell tumor produce an excessive amount of follicular hormone, which gives rise to endometrial hyperplasia and uterine bleeding. When these tumors occur in elderly women, far past the menopause, there is brought about a sexual and genital rejuvenation due to the estrin produced by the neoplastic cells. The breasts and the external genitals hypertrophy, and pseudomenstruation sets in."

The diagnosis of this condition is not always easy. Good authorities believe that about 1 per cent of ovarian tumors associated with uterine bleeding in elderly women may be granulosa cell tumors of the ovary, provided neoplasm of the cervix and uterine body can be ruled out. It is also asserted that a tremendous amount of estrin is elaborated by these tumors in all age groups and can be demonstrated in the blood and urine, but, apparently, the estimation of estrogenic substances in the blood and urine has not often been done prior to operation.

In this connection, it is well to remember that a malignant tumor associated with granulosa cells might produce the same blood and urine test results. Also, during the active period of sexual life, it will be necessary to rule out ectopic pregnancy. A diagnostic curettage in an elderly woman, if it reveals cystic hyperplasia of the endometrium, indicates that granulosa cells are at least associated with any ovarian tumor present. It would seem that, in a woman who has long since passed the menopause, a flow of menstrual-like, dark, liquid blood might furnish the first clue to a diagnosis, especially if there should appear to be some periodicity to the flow.

In our case, menstruation ceased at the age of 40 and returned at 54, there being a period of complete amenorrhea of 14 years; its return was painless, surprising, and in the midst of the best health the woman had ever enjoyed. She stated that during the first postmenopausal flow, she experienced the same sensations she had at menstrual time in her early life, except that, being "cancer minded," she was terrifically frightened.

To our personal knowledge, this patient had had an ovarian tumor, thought to be a cyst of the right ovary, for more than 15 years: it was present for at least one year before the cessation of normal menstruation and for 15 years prior to the first postmenopausal flow. It was, therefore, present 15 years before it functioned as a granulosa cell tumor, or 15 years after it was originally discovered by one of us (F. L. B.).

These tumors seem to be definitely malignant at times, while in other cases they seem to be clinically nonmalignant. In many instances, they seem to occupy the ovary with some other tumor, while in other cases the granulosa cell tumor fills the ovary entirely.

The typical granulosa cell tumor is described[3] as "an encapsulated growth, the capsule being smooth, firm and fibrous. It is not adherent to the surrounding structures. The capsule may vary in thickness in different places. The tumor is not, as a rule, lobulated. The blood supply to the tumor is rich, and large vessels may be seen upon its surface. On section, the tumor is found to be of solid, soft consistency, or, more commonly, partly solid and partly cystic. The color of the tumor is often bright yellow, about the color of a ripe corpus luteum. Some tumors have a pinkish, fleshy color as described by Telinde." Our case conforms to this description in practically all details, and we are disposed to regard it, therefore, as being clinically nonmalignant.

Case Report.—M. H., white, female, age 54, married, has two children, ages 21 and 27, both living and well. She was married at the age of 22. She was operated upon between the births of the children: A uterine suspension was performed, the left ovary resected, and perineal and cervical repairs were made. At the birth of the second child, the lacerations were reproduced, but the cervix was never repaired. Menstruation began at the age of 12, continued to be normal after the operation, and ceased at the age of 40, but she did not have any of the nervous, mental, or vascular symptoms usually accompanying "the change" and had often "wondered why."

On August 11, 1938, a painless vaginal flow of blood appeared. This was accompanied by swelling of both breasts and nervousness, which were the symptoms she had experienced at menstrual time in early life, and she thought, also, that the blood "looked exactly like menstrual blood." On examination, elsewhere, two small ulcers were found on the borders of the old cervical laceration. At a subsequent examination, two small ulcers were found on the borders of the laceration, but they were not bleeding and appeared to be simple ulcers resulting, probably, from exploded cervical cysts. In the right ovarian region, there was found a round, elastic, freely movable tumor, thought to be a cyst. It was about the size of a baseball. The uterus was thought to be a little larger and a little softer than usual for one of her age. This ovarian tumor was known to have been present 15 years or more and was not thought to have any connection with the bleeding.

The ulcers, which were small, round, superficial, and not indurated, were widely excised with all scar tissue, and the cervix was repaired. The uterus was curetted as a precautionary measure.

The pathologic report of the cervical tissue and the uterine scrapings was negative for malignancy, and it was considered a "cystic degeneration of the cervix."

In about six weeks from the time of this operation, a painless, bloody uterine flow again came on. This flow again resembled menstrual blood and was accompanied by such symptoms as she had experienced in early menstrual life. An examination now revealed that the cervix was soundly healed, and a slight, painless menstrual-like flow was exuding from the cervical canal. It was now thought that the curette had missed some pathologic lesion in the uterus, or that the ovarian tumor was the cause of the bleeding, and the complete removal of the uterus and adnexa was undertaken.

At operation, the uterus was found to be a little larger and a little softer than we

would have expected and was not atrophic. On the fundus was a small subserous fibroid. The left ovary had been removed at former operation. The right ovary was about the size of a baseball, was elastic, freely movable, showed no evidence of adhesions, was completely encapsulated, showed a uniform, bright, pinkish-yellow color through the capsule, and was suspended by a short, flat, divided pedicle from the broad ligament.

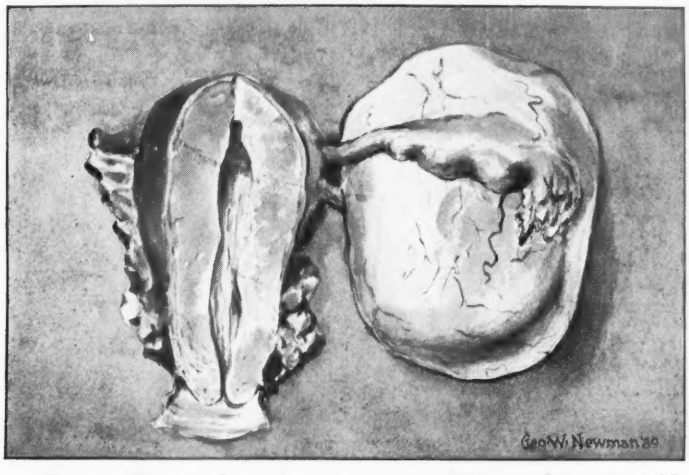


FIG. 1.—Uterus, tube, and ovarian tumor. Note smooth exterior with prominent vessels. The uterus is larger than normal postmenopausal organ, with abnormally thick walls and endometrium.

Pathologic Examination.—Gross: Dr. A. H. Braden: "The ovary measures 6x7x6 cm. and is well encapsulated. There are large vessels coursing over its surface. The tube is separated from it with difficulty (Fig. 1). The tumor is elastic, and, upon section, is a lemon-yellow color. The cut-section has some evidence of lobulation and a tendency to bulge (Fig. 2).

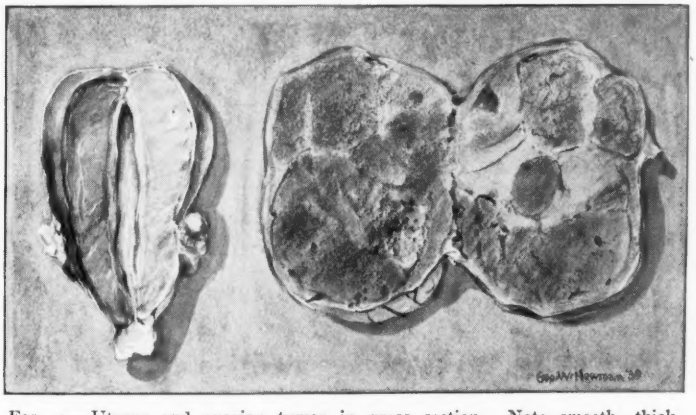


FIG. 2.—Uterus and ovarian tumor in gross section. Note smooth, thick, fibrous tumor capsule and lobulated cut surface.

"Microscopically, sections of the ovary show solid alveoli surrounded by a basement membrane. The cells have characteristic appearance. The cytoplasm is granular, and the cells have a somewhat spindly appearance (Fig. 3). This tumor is regarded as of low malignancy.

"The uterus measures 8x6x5 cm. The wall is thick and fibrous and the endometrium is more or less atrophic." (The uterus had been thoroughly curetted six weeks before.)

The endometrium showed gland acini to be rather scant and with some irregularity as to size and shape. The endometrium did not show hyperplasia, but the gland acini did show evidence of follicular hormone activity (Fig. 4).

Pathologic Diagnosis.—Folliculoma, or granulosa cell tumor.

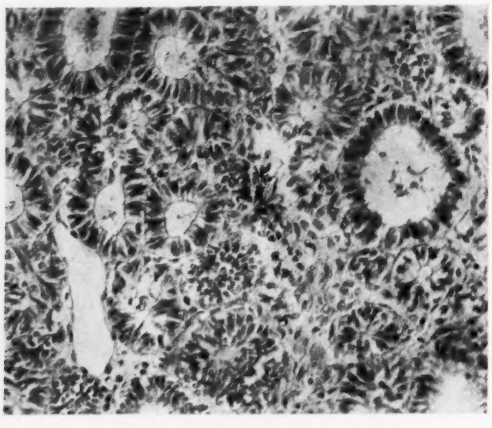


FIG. 3.—Photomicrograph of the ovarian tumor showing the granulosa type cells arranged in places to form small cysts.

FIG. 4.—Photomicrograph of the endometrium. Note cystic changes in glands which are lined with ciliated columnar epithelium, the picture indicating follicular hormone stimulation.

COMMENT.—A typical granulosa cell tumor of the right ovary is presented, wherein the right ovary had been known to be the site of a tumor for at least one year prior to the cessation of normal menstruation and for at least 14 years, through a period of complete amenorrhea, prior to the postmenopausal bleeding.

The uterus was slightly enlarged and slightly soft and was not atrophic. The endometrium presented the, so-called, Swiss cheese appearance.

After the removal of the tumor she suffered the usual climacteric symptoms—occasional headache, nervousness, hot flushes and frequent perspiration.

An additional instance of this pathologic condition is herewith presented, through the courtesy of Dr. A. O. Singleton, of Galveston, Texas.

Case Report.—Dr. A. O. Singleton: G. W. K., white, female, age 51, widow, mother of two children ages 16 and 18, both of whom are living and well, was admitted to the hospital because of postmenopausal bleeding in June, 1939. The menstrual history obtained at that time was that menstruation began at the age of 11 with 28-day intervals and of four to six days' duration. It was regular up to the age of 45. Then it became very irregular as to time and duration, until there was a complete amenorrhea lasting two years. It then returned and was again very irregular until it became almost continuous, when she was sent to the hospital for curettement. This was performed, and a microscopic diagnosis of endometrial hyperplasia was made.

About one month later, she was admitted to the Surgical Service for operation upon the colon, and, during the progress of this operation, a solid tumor of the left ovary was found and removed.

Pathologic Examination.—Microscopic: Dr. T. G. Blocker, Jr.: "The section reveals a remarkably uniform picture of cylindroid shells and cords of anaplastic epithelial cells intertwined with young fibrous tissue. The nuclei of the epithelial cells are regular in size and in shape, but as a whole they are elongated and vesicular with moderately sized nucleoli. The fibrous tissue, quite cellular itself with large nuclei, appears to have formed secondarily to the neoplasia resulting in more or less self-encapsulation process. There are no pseudofollicles formed."

Grossly, the specimen was covered by a serous endothelial membrane. Was firm and nodular. It measured 6x5x4 cm. There was slight tendency to lobulation and it was pinkish-yellow in color. *Pathologic Diagnosis:* Cell tumor of the ovary—cylindroid.

We would theorize, if we may, that, perhaps, the case we report did not have a complete and normal menopause except as to the cessation of menstruation; that there was, for 14 years, sufficient estrogenic hormone stimulation to prevent atrophy of the uterus and endometrium but not sufficient to produce menstruation, but, when this estrogenic function reached a certain maturity or, perhaps, a certain balance of power, menstruation was resumed.

We wish to thank Dr. A. H. Braden, Dr. Paul Brindley, and Dr. Truman Blocker, Jr., for their assistance in preparing this paper.

REFERENCES

[1] Dockerty and MacCarty: Granulosa Cell Neoplasm with a Discussion of Possible Histogenesis. Amer. Jour. Obstet. and Gynec., **38,** 698, October, 1939.

[2] Crossen and Crossen: Diseases of Women. 8th Edition, 761, 1935.

[3] Pratt, F. B.: Granulosa Cell Tumors of the Ovary: A Review of the Literature. Jour. Obstet. and Gynæc., Brit. Emp., **44,** October, 1937.

[4] Novak, E.: Amer. Jour. Sur., **24,** 595–601, June, 1934.

[5] Dockerty and MacCarty: Granulosa Cell Tumors. Amer. Jour. Obstet. and Gynec., **37,** March, 1939.

DISCUSSION.—DR. S. L. LEDBETTER, JR. (Birmingham, Ala.): I have never seen a patient with a granulosa cell tumor, but have been very much interested in ovarian tumors associated with secondary sex changes since operating upon a patient with an arrhenoblastoma. My attention was first called to this subject by reading the article by E. Novak and J. H. Long, published in the Journal of the American Medical Association, September 30, 1933. One week later I saw the patient with the arrhenoblastoma. This has been re-

ported in detail by McLester in the Archives of Internal Medicine, 57, 773–786, April, 1936.

I first saw this patient with Doctor McLester in October, 1933, and I am quite sure that we would not have recognized the disease had it not been for Novak's article. This patient was a young woman, age 32, with a history of seven pregnancies—five full term and two miscarriages. The youngest child was born in March, 1930. She nursed the child for several months; and menstruated on the fourth and sixth months after the birth of the child, and then stopped menstruating. Shortly afterward she noticed that she tired easily, began to lose weight, began to develop a beard, and to assume male characteristics. On examination we found that her voice was husky; she had a male type of figure; quite a heavy beard, so much so that it required daily shaving; a clitoris almost as large as the little finger; hair on the legs; male type of pubic hair; and a large tumor of the right ovary, the size of a grapefruit.

At operation, we removed a tumor of the right ovary. On the left side, coming off the broad ligament, there was another tumor of the same character, but much smaller, being about 2 cm. in diameter. The left ovary was fibrous and smaller than normal.

The patient made an uneventful recovery; and began to menstruate exactly 29 days following the operation. After ten days, her voice began to clear and, at the present time, it is perfectly normal except when singing, when it is apt to break. She has increased in weight, the breasts are more normal, there is very little hair on the legs, shaving is not necessary, and menstruation is normal.

Dr. Albert O. Singleton (Galveston, Tex.): I might say this patient Doctor Barnes reported had been through the Gynecologic Department, and they searched for the cause of the menstrual flow. She was referred to surgery for marked prolapse of the rectum. We were not particularly interested in the gynecologic side and were performing an intra-abdominal operation for the cure of the prolapse, when this tumor was observed and removed. The menstrual flow has not occurred since the tumor was removed.

Dr. Frank L. Barnes (Houston, Tex., in closing): I enjoyed Doctor Ledbetter's discussion and also his report of his case. I know very little about these tumors. The one I reported was one of my surgical surprises and I thought probably if I had another I could diagnose it with one operation instead of two.

THE MAINTENANCE OF PREGNANCY IN THE HUMAN AFTER REMOVAL OF BOTH OVARIES*

CASE REPORT

WITTEN B. RUSS, M.D.
SAN ANTONIO, TEXAS

EXPERIMENTAL WORK on such animals as the rabbit has demonstrated that the corpus luteum is essential to the maintenance of pregnancy during the first two or three months. Experiments on monkeys, reported by Carl Hartman,[1] tended to show that pregnancy could be maintained in these animals when ovariectomy is performed some time after nidation. How soon after nidation, however, the corpus luteum remains indispensable for the maintenance of pregnancy has been determined for only a few mammalian species. The pregnant rat, mouse, or rabbit, for example, almost invariably aborts after castration. In man the matter is under dispute. From the literature, many cases can be cited in which abortion was seen to follow removal of the corpus luteum, while there remain positive cases in which castration did not interfere with pregnancy.

Paul N. Leech, secretary of the Council on Pharmacy and Chemistry of the A.M.A., stated in a letter, dated July 25, 1939: "It is well-known at the present time that the removal of the ovaries after the third month of pregnancy in the human does not usually interrupt the pregnancy. S. A. Asdell[2] has collected from the literature a series of cases in which the ovaries were removed during pregnancy, and he found that most of the pregnancies proceeded in the usual fashion.

"Most authorities agree that the placenta takes over the function of the ovaries at this time and elaborates the various hormones which are normally found in pregnancy. The pregnandiol excretion of a pregnant castrate was found to be normal, which indicates that the placenta was elaborating a normal amount of progesterone. It, therefore, seems likely, according to endocrinologists, that *progesterone administration is not necessary in the woman* who has had her ovaries removed after the third month of pregnancy. The estrogenic and gonadotropic substances are also found in undiminished amounts in the urine following removal of the ovaries.

"It is also known that ovariectomy in monkeys, after the early stages of pregnancy, does not, in most cases, interfere with the pregnancy (Hartman)."

Dr. Virgil S. Counsellor of the Mayo Clinic, in reply to an inquiry, says: "It is quite generally agreed that the corpus luteum's imperative value is during the first two months of pregnancy, and its value decreases as pregnancy

* Read by title before the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

advances." He recommends proluton (progestin derivative of corpus luteum) if there seems to be any irritation of the uterus and threatened miscarriage.

Dr. Emil Novak, also in reply to a letter, says: "It is now quite clearly established that the corpus luteum, so indispensable in the maintenance of early pregnancy in such animals as the rabbit, is certainly not indispensable in the human female." He thinks, however, that it is advisable to use progesterone after the operation during the first half of the pregnancy.

Dr. Richard W. Telinde states: "I do not know of any case, in the literature, in which pregnancy has gone to term (in the human) after removing the ovaries as early as the second month. There are a good many cases reported that have gone to term later, and the earliest one that I have ever heard of was at the end of the third month." Eiss[3] reports a case of a woman four months pregnant, in whom both ovaries were removed, followed by normal delivery of a live baby at term.

Case Report.—M. E. T., female, age 34, married 15 years, para +, was admitted to the Medical and Surgical Memorial Hospital, June 20, 1939, complaining of severe pain in lower abdomen with pressure on the bladder and rectum; frequent urination; distention; nausea; and vomiting. In 1929 (ten years ago), the right tube, ovary, and appendix were removed. Eight years ago her only child was born. She has had no other illnesses. Her menstrual history is negative; last menstruation, April 9 to 14, since which time she has shown all the signs of pregnancy. On June 16 four days before admission to the hospital, she was seized with a severe pain in her pelvis and left lower abdomen, accompanied by nausea and vomiting.

Physical Examination.—Temperature 100° F.; respiration and pulse normal; W.B.C. 11,200; neutrophils 90; Wassermann negative; Aschheim-Zondek positive; urine negative except for trace of albumin.

Her abdomen was distended. She was tender and rigid in the left lower quadrant. On pelvic examination, a large, tender, fixed mass in the left side of the pelvis was found. Uterus was about the size of a two months' pregnancy.

On June 20, under general anesthesia, the abdomen was opened in the midline. A considerable amount of free, blood-tinged fluid was found. The uterus was about the size of a two months' pregnancy. The right tube and ovary were absent. The left tube and ovary, which were black and gangrenous from torsion, were removed.

The pathologic report showed the ovary to be 9x6.5x4 cm., and both it and the tube showed marked congestion, hemorrhagic infiltration, and early, moist gangrene. The corpus luteum of pregnancy is seen on gross-section. This measured 18 Mm. at its longest diameter. The central part showed cavitation, the cavity being filled with bloody fluid. The patient made an uneventful recovery.

Progestin, 1 cc., was started on the second postoperative day, and continued every other day for several weeks. There were never any symptoms referable to absence of ovarian hormones. The patient often complained of dizziness and nausea after the injection of the progestin. The progestin was discontinued at the end of the fourth month. On January 8, she was delivered of a normal, eight pound, male child. Both mother and child are in good condition.

This case is interesting chiefly because of:

(1) The general impression that abortion is almost certain to result from the loss of both ovaries during pregnancy, especially during the first three months.

(2) The almost universal belief that the pregnant woman is a poor surgical risk for abdominal and pelvic operations. Barring bad technic and infection, there is no reason why a pregnant woman should be a bad risk.

(3) The theory that it is necessary to give progestin to balance the loss of the ovarian hormone during the remainder of the pregnancy. We are not sure that it is necessary to give progestin, and if it is necessary, it is important to know the amount required and whether overdoses may not do more harm than good. Zondek[4] has demonstrated that the prolonged application of large doses of follicular hormone on the nonpregnant uterus of a rabbit produce (1) hyperemia; (2) glandular-cystic hyperplasia of the uterine mucous membrane; (3) infarct-like necrosis of the muscle layer, and aseptic suppuration of the uterine cavity. If prolonged doses of the follicular hormone result in so much damage to the nonpregnant uterus, it must be apparent that overdoses of the corpus luteum hormone on the pregnant uterus must be guarded against.

(4) Finally, the mental and nervous state of the pregnant woman is badly damaged by the constant suggestions from everyone, including the surgeon, that she and the fetus are both in imminent danger from a surgical operation, and that if operated upon she must become a hospitalized invalid during the remainder of her pregnancy, and be subjected to great expense and great mental strain. Seven or eight months' pregnancy is enough without the added burden of fear and the addition of unnecessary expense.

REFERENCES

[1] Hartman, Carl G.: Noneffect of Ovariectomy During Pregnancy in Rhesus Monkey. Amer. Jour. Obstet. and Gynec., **37**, 287, February, 1939.

[2] Asdell, S. A.: Growth and Function of the Corpus Luteum. Physiol. Rev., **8**, 313, July, 1938.

[3] Eiss, Stanley: Pregnancy with Bilateral Ovarian Cyst. Amer. Jour. Surg., **10**, 338, November, 1930.

[4] Zondek: Jour. Exper. Med., **63**, 789, June 1, 1936.

MODIFIED KONDOLEON OPERATION FOR SCLEROSED LEG WITH ULCERATION*

FREDERIC W. BANCROFT, M.D.,
MARGARET STANLEY-BROWN, M.D.,
AND
R. F. TAYLOR, M.D.
NEW YORK, N. Y.

THE FOLLOWING QUOTATION from an article by A. J. Cokkinis, in Maingot's Postoperative Surgery, 3, 3993–3994, describes very well the local skin lesions found in the condition we are describing:

"Numerous morbid conditions occur in association with varicose veins, but they are dependent, not on the varices, but on the venous stasis, the blood stagnation, and the resulting local anoxemia, accumulation of toxic metabolites, and local tissue acidosis.

"Associated skin changes are perhaps the most striking. Eczematous dermatitis (varicose eczema) is a common result and is seen in various types—erythematous, scaly and weeping; it may be localized, or it may involve the whole of what is known as the ulcer-bearing area of the leg. Pigmentation occurs in the form of brownish macules which coalesce to form large areas of discoloration, and which may ultimately also occupy the whole of the ulcer-bearing area. Pruritus is very common, and dermatitis artefacta may result from scratching. Other common results are alopecia, and a dry and hypertrophied skin.

"Edema of the ankle and lower part of the leg occurs in advanced cases, but quite distinct from this is a brawny swelling of the limb which is sometimes seen, and which is caused by hypertrophy of the subcutaneous and deeper areolar tissues owing to lymph stasis. An interesting result of the local hyperemia, and one to which attention has only recently been drawn, is a decalcification of the lower part of the leg bones."

In various text-books of surgery the injection treatment of varicose veins has been well described but no remedy has been suggested for those cases which do not respond to injection. We, therefore, feel that it is advisable to emphasize again the advantages of the modified Kondoleon operation.

Take, for example, the past histories of three of our typical cases:

TYPICAL CASE REPORTS

Case 2.—A. K., age 41, was admitted to the U. S. Veterans Hospital, April 11, 1938, complaining of ulceration of both legs. For the past seven years he has had to wear bandages.

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

*Surgical Examination**—This man has on each leg almost complete encircling ulcers of long standing. He has persistently negative Wassermann and Kahn tests. The feet beyond the ulcers are edematous with marked scar tissue, almost an elephantiasis of the ankles and upper feet. There is an area above each ulcer of thickened scar tissue. The senior author made the following consultation note on admission:

The left leg, I believe, is untreatable except by amputation, as the circular ulcer is constricting the circulation and lymphatics so that any operative procedure would eventually be unsuccessful. The right leg is where the ulcer only goes two-thirds around the leg. I believe it would be worth while attempting a modified type of Kondoleon operation, cutting through the scar tissue down through the fascia and allowing

FIG. 1.—Case 2. U. S. Veterans Hospital: Anterior view following Kondoleon's operation upon both extremities with "well-taken" skin grafts. Following this photograph another Kondoleon operation was performed posteriorly, in order to relieve any resultant edema or scar tissue.

FIG. 2.—Case 2. U. S. Veterans Hospital: Lateral view. Notice lack of edema in feet.

expansion and the possibility of anastomotic lymphatic circulation. If this were successful, excision of scar tissue and skin grafting would have a fair possibility of success (Figs. 1 and 2).

Treatment.—September 27, 1938: Modified Kondoleon operation, right leg. October 24, 1938: Pinch-grafts to right leg. November 4, 1938: Modified Kondoleon, left leg. Additional skin grafts, right leg. November 18, 1938: Pinch-grafts to left and right legs. November 25, 1938: Additional pinch-grafts, left leg. April 4, 1939: Kondoleon repeated posterior to previous incision of both legs. Undertaken because of some peripheral swelling following original procedure. May 5, 1939: Pinch-grafts, both legs. July 13, 1939: Discharged. Hospitalization days—one year three months. Following first operation—ten months, 16 days. Following second operation—three months, nine days. *Final Result:* Both legs well healed, without pain or swelling.

*I am rather ashamed to include my initial consultation note on this particular patient, but I do so because I believe it will show that our opinion has changed since that time.

After the procedures enumerated above, this patient has two legs completely epithelized, with no edema of his feet and ankles, and a soft calf where previously the ligneous induration was present.

Case 6.—J. R., age 45, was admitted to the U. S. Veterans Hospital, May 5, 1932, complaining of an ulcer of his left leg, which he states has been present since 1929, and for which he has used many types of salves.

Surgical Examination.—On the lateral aspect, middle third of the left calf, is an ulcer about 4x3 inches. Surrounding this ulcer is an area of pigmentation and brawny induration. The leg shows many moderate-sized varicose veins. Circumference of the left leg in this area is about three and one-half inches greater than the right. He was treated with ultraviolet ray and elastic stocking. The varicose veins were not injected. Discharged, June 28, 1932.

Second admission, August 14, 1933. Discharged, November 21, 1933. Chief Complaint: Ulcer, varicose, left leg. Size at this time was 3x6 inches. He was treated by bed rest, ultraviolet ray, elastic stocking. Varicose veins not injected.

Third admission, August 15, 1935. Discharged, November 18, 1935. Following the last period of hospitalization, at which time the ulcer had been healed, there had been no difficulty with it until about two weeks before the present admission, when the ulcer again reappeared. At this time it was about 3x4 inches and showed a brawny, pigmented area surrounding it involving most of the middle third of the leg. Treated by ultraviolet ray, bed rest, and elastoplast bandage.

Fourth admission, February 14, 1936. Discharged, September 16, 1936. Ulcer was healed following last period of hospitalization until two weeks before present admission. Treatment by ultraviolet ray, bed rest, elastoplast bandage, and one varicose vein adjacent was injected. He was discharged as healed.

Fifth admission, December 21, 1936. Discharged, February 19, 1937. Ulcer stayed healed until four weeks before present admission. Examination at this time shows an ulcer 3x4 inches. Description same as on previous admission. Treatment by bed rest, ultraviolet ray, elastoplast bandage. Discharged as healed.

Sixth admission, March 31, 1937. Discharged, June 3, 1937. Examination: Ulcer 3x4 inches. Treated by bed rest, ultraviolet ray and elastoplast bandage.

Seventh admission, October 9, 1937. Discharged, November 29, 1937. Ulcer 3x4 inches. Treatment by bed rest, ultraviolet ray, elastoplast bandage.

Eighth admission, March 20, 1939, complaining of varicose ulcer of left leg. There have been seven previous admissions for this same condition. About six weeks ago the ulcer ruptured on the left leg. At this time it was 2x3 inches. There had been no recent injury.

Operation.—April 27, 1939: Kondoleon procedure for varicose ulcer, chronic, left leg. There was a chronic, ulcerated area on the lateral surface, lower one-third of the left leg. The base of this ulcerated area was thickened and firmly attached to the fibula by firm, inflammatory adhesions. Beginning just above the level of the malleoli on the anterior surface of the left leg, a vertical incision was carried straight upward along the crest of the tibia to the extent of about eight inches. This was carried deeply through the skin, subcutaneous tissue and fascia and by splitting procedure to the site of the adhesion between the muscle layers. The tibialis anticus was placed laterally and posteriorly beginning and ending at the same level. The muscle was freed from the fibula. The two incisions were then connected by undermining, lifting up the entire area of skin, subcutaneous tissues and muscle, freeing all deep adhesions to the fibula. Bleeding was controlled and the resulting defects were tightly packed with vaseline saturated gauze.

Operation.—June 1, 1939: Skin graft, left leg. The skin of both thighs was shaved

FIG. 3.—Case 6, U. S. Veterans Hospital: Note general swelling of leg, widespread where skin grafts were applied. In this case there should have been further incisions to release scar tissue.

FIG. 4.—Case 1, New York City Hospital: Photograph of ulcer before operation. Note bronzing of skin, and size and chronicity of ulcer.

FIG. 5.—Case 1, New York City Hospital: Three years after operation. Leg has remained healed during this period. Skin is soft.

and cleansed following which multiple pinch-grafts were taken from both thighs and transferred to the denuded areas on the left leg. When the operation was terminated, the grafted area was dressed and the leg placed in a light plaster encasement.

The majority of the skin grafts were successful. Subsequent splinting of the area with elastoplast bandage is completing epithelization. Patient remaining in the hospital. Granulation area now 1x1½ inches, roughly diamond-shaped (Fig. 3), and improving steadily but slowly. Patient is ambulant and walks with slight limp. Surgical dressings only therapy.

City Hospital **Case** 1.—H. K., age 44, was admitted to the New York City Hospital, October 30, 1936. Diagnosis: Varicose ulcers of both legs, right (Fig. 4) worse than left. Duration, 19 years.

Treatment.—Vein injection without success up till 1928. October 30, 1936: Ligation of veins of both legs. February 15, 1937: Ulcers excised and grafted. No improvement. March 22, 1937: Religation of right saphenous. April 23, 1937: Kondoleon and Thiersch grafts to right leg. June 10, 1937: Kondoleon on scar tissue on back of leg. June 14, 1937: Thiersch grafts to back of leg. June 30, 1937: Discharged with both legs healed and Unna paste boots. Legs healed in two months' time.

Follow-Up.—Unna paste boots applied for almost a year. Right leg has stayed healed for three years (Fig. 5). Left leg, which was not operated upon, ulcerated again. Some residual swelling in right leg. Bad hygiene and living conditions. Drug addict.

It is because of the great economic waste to both patient and hospital that we began our study of this group of long-existing ulcers that have resisted the usual types of treatment. Their appearance is characteristic: A leg with a constriction often clearly visible at the site of maximum ulceration; a pigmented, bronzed skin with one or several ulcers with dirty, unhealthy granulations. Often there is edema of the foot and ankle distal to the ulcer. On the palpation of the leg a ligneous consistency is felt, especially posterior to the tibia and fibula. This induration is confined largely to the pigmented area, and shades gradually into normal tissue cephalad to the lesion. Distal to the involved area the foot may be cold, edematous and moist. While in the early period of the disease varicose veins may be observed, at this late period they may not be noticeable. One must assume that either edema or repeated attacks of lymphangitis and phlebitis have caused their disappearance. We desire to emphasize that the treatment we recommend is not for early varicose ulcers that may be readily cured by injection of the veins with sclerosing solutions, rest and use of Unna paste boots. Many of our case histories show repeated hospital admissions during the previous ten or 15 years.

Our microscopic studies of tissues removed at operation reveal the following findings: Sections show an atrophic epidermis with loss of rete pegs and a very marked hyperkeratosis of the surface (Fig. 6). Below the epidermis the subcutaneous tissue is practically replaced by a thick layer of heavy, fibrous connective tissue. This layer is about three times its normal thickness. Scattered through these fibers are large and small clumps of brown pigment, probably hemosiderin (Fig. 7). The blood vessels are few and are surrounded and compressed by scar tissue (Fig. 8). Around the vessels and under the epidermis there is an infiltration of lymphocytes and plasma cells. The glands are buried below the scar tissue and show markedly dilated ducts which are filled with secretion (Fig. 9). This same scarring

FIG. 6.—Atrophic epidermis. No hair. Compressed sebaceous and sweat glands. Marked fibrosis.

FIG. 7.—Scar tissue and deeper layer, showing marked pigmentation and chronic infection.

extends into the subcutaneous fat. The striking features in these sections are: (1) The thinned-out epithelium without hair. (2) The dense scar tissue, with compression of the glandular structures and cystic dilatation of the ducts deep in the corium.

We are not claiming any originality in our procedure. Indeed, Hugh Trout, of this Association, in 1929, presented an excellent paper on this very subject. Trout reviewed the literature, giving great tribute, as do we, for the early and very constructive work of Doctor Matas and others. We have based the theory of our work on a slightly different concept than that held by Trout. Our operative procedure is predicated upon the concept that the encircling scar tissue is the main factor that prevents these chronic ulcers from healing. We believe with Trout that lymph and venostasis and infection are the inciting factors of this condition. We believe that after the constrictive scar tissue has been relieved, early skin grafting diminishes infection, prevents the secondary scar tissue formation, and, therefore, allows the reestablishment of the lymphatics. Whether that be by deep or superficial anastomoses has not been proven.

Operative Technic.—The leg is prepared for several days preoperatively with wet 1:5,000 neutral acriflavine dressings and bed rest with moderate elevation—enough to empty the veins and still give the maximum of arterial supply.

At operation, two or three linear incisions are made from the healthy soft portion of the leg cephalad to the indurated area down to the edematous area of the foot and ankle. The incisions are usually made posterior or even with the tibia and fibula, and often one is made in the posterior third of the calf. The incisions are carried down through the scar tissue until soft, healthy tissue is encountered. In a few of our cases this necessitated exposing the posterior surface of the tibia and fibula. There is occasionally profuse bleeding from varicose veins encompassed by dense scar tissue. It may be necessary to control these vessels by suture.

The leg is treated by wet or vaselined gauze dressings. When the linear incision has been made, it is interesting to note how the wounds gape open, causing an increased circumference of the leg.

At first, we attempted immediate skin grafting, but had too many failures from delayed ooze or infection. Now we graft, usually by pinch- or small Thiersch grafts in seven to ten days, when the granulating surface is free from sloughs. It is important to emphasize the grafting before scar tissue again begins to contract the circumference of the leg.

Usually, the ulcers over the tibia are not attacked at the primary operation. In one or two cases they have been undermined by freeing their bases at the borders from the underlying deeper structures. If these ulcers are circular, surrounding the leg, the longitudinal incisions are carried through them.

It is interesting to note that after the Kondoleon procedure epithelization often takes place rapidly and the ulcers are almost healed by the time the leg

FIG. 8.—Blood vessels, deep in fat, surrounded and compressed by scar tissue. Chronic infection.

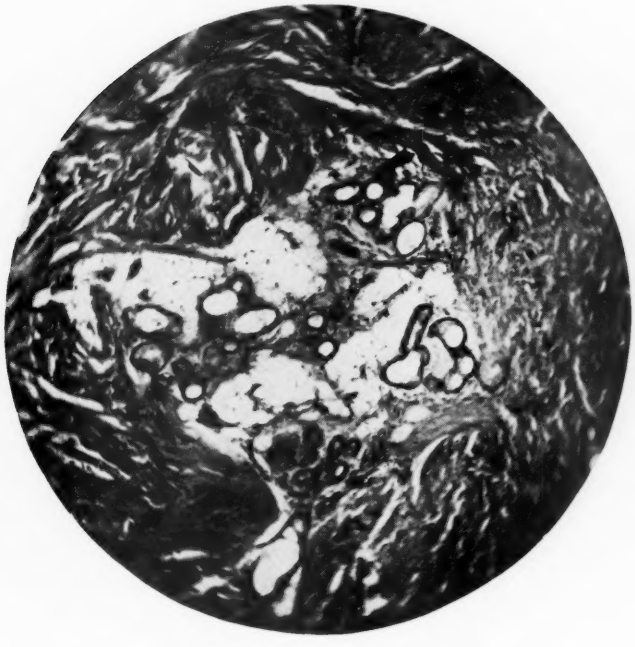


FIG. 9.—Dilated hair follicles deep in subcutaneous tissue.

is ready to be skin-grafted. After epithelization is complete, whirlpool baths are efficacious to improve the local circulation. When the patient is first allowed up and about, either an Ace bandage or an Unna paste boot is necessary to prevent the initial static edema.

The brawny induration, noted before operation, begins to disappear while the patient is still in bed. When the patient first assumes the erect posture a mild static edema is apt to appear unless either Ace bandages or Unna paste boots are applied. For the first two to three months these cases must be closely followed to determine how long the bandages should be left on. Our poor results have been from too early removal of compression, allowing edema before the complete restoration of the lymphatic drainage has occurred.

We wish to present a preliminary report of 20 cases—ten from the New York City Hospital, nine from the U. S. Veterans Hospital No. 81, and one from the New York Infirmary for Women and Children, which we have included with the New York City Hospital cases:

ABBREVIATED REPORTS OF 20 CASES

Case 1.—B. D., age 61, was admitted to the U. S. Veterans Hospital, June 27, 1938, complaining of an ulcer of the left leg, which had been operated upon one year before, necessitating a hospitalization of six months. Examination revealed infiltration and induration extending into the deep structures of the posterior aspect of his leg, responsible for the repeated breaking down of any surgical attempts to cover over the plastic and skin grafts. One-half of the material previously implanted still remained and appeared to be in fairly good circulatory condition.

Surgical Consultation.—This patient, a man of 61, is suffering from an indolent ulcer on the posterior surface of the left leg. He was operated upon at the Veterans Hospital in San Francisco, with pedicle skin grafts. These broke down last January. The evidence at present is that two-thirds of the lower portion of the grafted area is filled with satisfactory skin. There appears a V-shaped ulcer 2x5 inches, above this area, with a base of infected scar tissue. Palpating the leg anterior to this area, it has ligneous consistency.

I do not believe that any attempt at skin graft for the present ulcer would be permanently successful, without releasing adhesions lateral to the ulcer, through the fascia, in order to produce a better lymphatic and vascular drainage of the leg. I would suggest that he be treated by elevation and wet dressings for a couple of weeks, then a modified Kondoleon operation lateral to the ulcer, with immediate skin graft; and then, after a period of rest and elevation, an excision of the ulcer, with the skin tissue involved, should be performed, followed by either full-tissue or pinch-grafts.

The patient was treated by bed rest, elevation, radiant heat, whirlpool, and ultraviolet radiation, from June 27, 1938, to September 13, 1938, without improvement.

Operation.—September 13, 1938: Two incisions were carried out, one mesial and the other lateral, one inch distant from the margins of the ulcer, paralleling the long diameter of the leg, carried down through the skin and subcutaneous tissue, musculature, to periosteum of the bone, relieving the tension in the tissues. The area, including the ulcer, blocked off by this incision was then lifted free from its attachments and allowed to remain as a bridging across the indurated area and beneath the ulcer. Apparently, the circulation in the immediate vicinity of the ulcer was improved by this procedure. No sutures were introduced. The leg was dressed with a vaselined dressing. No attempt was made to scarify or excise the ulcer proper. Ulcer healed promptly after this procedure without the necessity of skin grafting.

The patient was discharged, cured, December 1, 1938, after a total of five months and four days of hospitalization—two months and 18 days after the Kondoleon operation.

Case 2.—A. K. This case has been described on page 874.

Case 3.—M. McG., age 48, was readmitted to the U. S. Veterans Hospital, October 14, 1938, complaining of a severe ulcer of the left leg, which had persisted since 1933.

Readmitted, August 7, 1934. Discharged, December 3, 1934. Diagnosis: Varicose ulcer left leg, severe. *Treatment.*—Consisted of local dressings, adhesive strappings and rest.

Readmitted, May 13, 1935. Discharged, August 27, 1935. Diagnosis: Varicose ulcer of left leg, 4x3 inches, with associated varicose veins. *Treatment.*—Injection of varicose vein. Ultraviolet radiation to ulcer in addition to adhesive strapping and bed rest. Decrease in size of ulcer primarily, only to return to original size.

Readmitted, April 21, 1936. Discharged, June 19, 1936. Diagnosis: Varicose ulcer of left leg. Varicose veins left leg, moderate. Since last hospitalization here (August 27, 1935) has been at Welfare Island for four months. Has had 62 pinch-grafts, without success, ulcer 5x4 inches. *Treatment.*—Elastoplast, rest. Pinch-graft, June 3, 1936.

Readmitted, July 19, 1937. Discharged, September 24, 1937. Diagnosis: Varicose ulcer, left leg, 2½x4 inches. Varicose veins, left leg. Thrombophlebitis, chronic, left leg. *Treatment.*—Rest, elevation of leg. Elastic bandage. Local dressings with gentian violet.

Readmitted, October 14, 1938. Discharged, March 7, 1939. Diagnosis: Ulcer, left leg, severe. Was at Rikers Island five months; Bellevue one month. *Treatment.*—November 1, 1938: Kondoleon operation. December 2, 1938: Skin graft. December 16, 1938: Skin graft. Whirlpool therapy following grafts. Discharged. Healed.

Case 4.—H. H., age 37, was admitted to the U. S. Veterans Hospital, July 11, 1936, complaining of varicose veins, left, severe; right, mild. Varicose ulcer, left leg. He had had varicose veins for 12 to 14 years, and had also had numerous ulcers on his legs since 1925. The present one, duration six months, was one inch in diameter. *Treatment.*—Injection, rest, dressings. Discharged September 17, 1936.

Readmitted, January 16, 1939. Diagnosis: Varicose veins, left leg. Varicose ulcer, left leg, which had reappeared three months ago and which was growing progressively larger. Now 3x4 inches. *Treatment.*—February 7, 1939: Kondoleon operation. March 8, 1939: Pinch-graft. Whirlpool therapy. Discharged, April 20, 1939. Epithelized, with no edema.

Case 5.—C. B., age 54, was admitted to the U. S. Veterans Hospital, February 27, 1934, complaining of a severe varicose ulcer on the left leg. *Treatment.*—Bed rest, adhesive strap dressings. Discharged, December 14, 1934. Cured.

Readmitted, June 14, 1935. Diagnosis: Varicose ulcer, chronic, left leg. One month following last discharge (December 1, 1934), ulcer again appeared. Discharged, July 9, 1935 (AWOL).

Readmitted, October 8, 1935. Diagnosis: Varicose ulcer, left leg, severe, three inches in diameter. Thrombophlebitis, chronic, bilateral, legs. *Treatment.*—Elastic bandage; ultraviolet radiation; local surgical dressings. Discharged, December 1, 1935. Cured.

Readmitted, June 14, 1937. Diagnosis: Ulcer, left leg, three inches in diameter. *Treatment.*—Rest; elastoplast; ultraviolet radiation; surgical dressings. Discharged, August 11, 1937 (AWOL); condition improving.

Readmitted, December 1, 1938. Diagnosis: Varicose ulcer, left leg. Phlebitis, left leg. *Treatment.*—January 11, 1939: Kondoleon operation, left leg. January 31, 1939: Pinch-graft, left leg. April 4, 1939: Kondoleon operation, left leg—cuff-like constriction following first Kondoleon operation to be relieved. May 17, 1939: Pinch-graft. September 15, 1939: Refused excision of scar tissue in base of previous Kondoleon operations. Patient given physiotherapy and adhesive bridging—finally epithelized. Dis-

charged, October 20, 1939. Epithelized but new skin appears thin with some edema still present.

Case 6.—J. R. This case has been described on page 876.

Case 7.—A. S., age 48, was admitted to the U. S. Veterans Hospital, April 10, 1939, complaining of an ulcer of the right leg, which has been present since 1927. He had been treated in the Brooklyn Naval Hospital three years ago, and also by private physicians and himself, with no improvement. *Treatment.*—Kondoleon operation, April 27, 1939. May 17, 1939: Pinch-graft. June 16, 1939: Débridement of scar tissue, at the site of the previous Kondoleon operation. June 26, 1939: Pinch-graft. August 19, 1939: Discharged. Wounds well healed.

Case 8.—C. C., age 42, was admitted to the U. S. Veterans Hospital, May 2, 1939, with a diagnosis of varicose veins of both legs; varicose ulcer, right leg. Duration,

FIG. 10.—Case 9, U. S. Veterans Hospital: Final result with complete epithelization and lack of edema of foot.

six months. Numerous small ulcers with pigmentation. Was treated with rest, local antiseptics and elevation. Patient gives a history of pain and swelling with enlarged varicose veins of both legs, for the past five years. About one year ago he developed some ulceration on the left leg which responded to injection treatment of the varicose veins and local treatment to the ulcers. He has also been receiving injections and local treatment because of the large ulcers of the right leg for the past six months. The right leg swells and becomes very painful.

Surgical Examination.—The left leg shows rather marked discoloration and increased pigmentation with numerous small, healed scars, the site of previous varicose ulcers. There are no enlarged clusters or veins present at this time. The right leg is dark, swollen and discolored. The lower third shows increased pigmentation and many small, ulcerated areas, some of which are encrusted. There are visible and palpable clusters of enlarged veins in the upper third of the leg and in the lower thigh, with many

small, hard areas, the site of previous infections. He gives a history of syphilitic infection and the lesions are suggestive of lues. Blood Wassermann is negative. Spinal puncture will be done and Wassermann done on the spinal fluid. *Diagnosis:* (1) Varicose veins, both legs. (2) Varicose ulcers, right leg. (3) Thrombophlebitis, chronic, right leg.

Treatment.—July 12, 1939: Kondoleon operation, right leg. August 25, 1939: Skin graft, right leg. The majority of the skin grafts were successful. Remaining in hospital.

Case 9.—J. B., age 46, was admitted to the U. S. Veterans Hospital, May 27, 1939, for varicose veins; varicose ulcers in both legs. Previous treatment in 1937 for same condition. Recurrence about ten months ago. Ulceration had been present since 1920. Nine admissions to various hospitals. Numerous ulcers.

Treatment.—June 8, 1939: Kondoleon operation, right leg. July 13, 1939: Skin graft. Remaining in hospital (Fig. 10).

NEW YORK CITY HOSPITAL CASES

Case 1.—H. K. This case has been described on page 878.

Case 2.—J. H., male, age 54, was admitted to the New York City Hospital in 1935, for varicose ulcers of both legs, for "years." Swelling and scleroderma. *Treatment.*—1933–1934: Injection of veins. Right leg healed, but developed osteomyelitis of foot. Left leg did not heal. 1935–1937: Several attempts to graft left leg ulcer failed. April 30, 1938: Kondoleon operation upon lateral side of left leg. May 12, 1938: Pinch-grafts. May 27, 1938: Pinch-grafts. June 30, 1938: Pinch-grafts. Ulcer healed and swelling disappeared.

Follow-Up.—November 16, 1939: Left leg has remained healed and free of swelling. Scleroderma still present. Right leg had to be amputated because of infection.

Case 3.—N. R., female, age 58, was admitted to the New York City Hospital, May 10, 1937, and presented swelling of left leg, following a hysterectomy 15 years ago. Ulcers developed 13 years ago. Healed once but recurred. Has large sloughing ulcers on both sides of left leg. *Treatment.*—May 21, 1937: Kondoleon incisions on either side of leg, through ulcers. May 25, 1937: Pinch-grafts to outer incision. May 28, 1939: Pinch-grafts to inner incision. June 29, 1937: Discharged healed.

Follow-Up.—November 16, 1939: Leg still well healed. Skin around leg soft (Fig. 11, 12, 13 and 14).

Case 4.—A. L., male, age 38, was admitted to the New York City Hospital, May 9, 1939, complaining of a varicose ulcer, right leg, with swelling. *Treatment.*—1935: Injections, without success. May 10, 1937: Kondoleon incision through ulcer. May 17, 1939: Thiersch grafts—took poorly. July 24, 1939: Discharged healed but without Unna paste boot.

Follow-Up.—November 16, 1939: Right leg very swollen. A few superficial ulcerations. Right leg three inches larger than the left. Referred for further rest and Unna paste boot.

Case 5.—C. G., male, age 73, was admitted to the New York City Hospital, March 25, 1938, complaining of varicose veins; and intermittent ulcers of the left leg, 12 years. *Treatment.*—April 11, 1938: Leg healed with bed rest, but scar tissue remained, so a Kondoleon incision was made through the ulcer area. Thiersch grafts applied with 95 per cent takes. May 27, 1938: Discharged healed, with Unna paste boot. Uncooperative and had some breaking down of wound.

Follow-Up.—June, 1939: Leg healed and no swelling.

Case 6.—J. W., male, age 54, was admitted to the New York City Hospital, May 1, 1939, complaining of varicose veins for years, and an infected ulcer for seven weeks. *Treatment.*—May 5, 1939: Kondoleon incision on outer side of leg. Fascia removed.

FIG. 11.—Case 3, New York City Hospital: After grafting the lateral surface of the leg following Kondoleon operation. Note wide spread of the scar.

FIG. 12.—Case 3, New York City Hospital: After grafting area of Kondoleon operation on mesial surface of the leg.

FIG. 13.—Case 3, New York City Hospital: Final result two and one-half years after operation—lateral surface of leg.

FIG. 14.—Case 3, New York City Hospital: Two and one-half years after operation—mesial surface of leg. Note softness of skin, with pliability and lack of edema of foot.

May 16, 1939: Pinch-grafts. June 6, 1939: Went home against advice. Not quite healed. Ace bandage on leg.

Follow-Up.—November 16, 1939: A few superficial ulcerations and some swelling.

Case 7.—M. B., female, age 41, was admitted to the New York Infirmary, July 20, 1939, and presented a varicose ulcer of the left leg, of 15 years' duration. *Treatment.*—1924. Leg ulcerated and healed spontaneously after one year. 1928. Ulcerated again, and healed after three to four months. June 31, 1939: Ulcer opened again and would not heal. July 31, 1939: Kondoleon incision through outer side of leg. Pinch-grafts applied immediately. August 22, 1939: Discharged healed with Ace bandage.

Follow-Up.—September 20, 1939: Did not apply bandage properly and small ulcerations began to appear. Put to bed and Unna paste boot applied. November 10, 1939: Boot removed. Leg healed. Admitted to hospital for arthritis. November 24, 1939: Leg well healed and tissues soft.

Case 8.—T. W., male, age 61, was admitted to the New York City Hospital, June 2, 1939, complaining of a varicose ulcer of the left leg, which had been present off and on for 30 years. *Treatment.*—June 12, 1939: Kondoleon incision both sides of leg. Pinch-grafts. August 3, 1939: Went home against advice; not quite healed.

Follow-Up.—None.

Case 9.—L. I., male, age 54, was admitted to the New York City Hospital, June 12, 1939, complaining of varicose ulcers on the calves of both legs. Swelling of the left leg present for "years." *Treatment.*—June 12, 1939: Kondoleon incision on both sides of left leg. Thiersch grafts immediately. June 22, 1939: More Thiersch grafts. June 29, 1939: Pinch-grafts. August 15, 1939: Discharged healed.

Follow-Up.—None.

Case 10.—F. L., female, age 41, was admitted to the New York City Hospital, April 10, 1939, complaining of varicose ulcers of both legs; with swelling for 16 years. *Treatment.*—April 1, 1939: Bilateral saphenous vein ligation. No improvement. April 19, 1939: Kondoleon incision, right leg; with fascial strip removed. April 26, 1939: Kondoleon incision of left leg; and skin grafts to right leg. May 17, 1939: Thiersch grafts, both legs. May 31, 1939: Thiersch grafts, both legs. June 19, 1939: Scar tissue on right leg incised and Thiersch grafts applied. June 26, 1939: Thiersch grafts to right leg. August 5, 1939: Transferred to Welfare Hospital. August 30, 1939: Discharged improved.

Follow-Up.—None.

Case 11.—W. C., male, age 68, was admitted to the New York City Hospital, April 20, 1939, complaining of a varicose ulcer of the left leg; duration, ten years. *Treatment.*—Injections, without success. May 1, 1939: Kondoleon incision to left leg; with fascial strip removed. May 8, 1939: Pinch-grafts. May 16, 1939: Pinch-grafts. May 26, 1939: Pinch-grafts. June 27, 1939: Finally healed. Tissues sluggish. July 1, 1939: Discharged.

Follow-Up.—November 16, 1939: Large deep ulcers of both legs. Probably some arteriosclerosis responsible for this failure.

ANALYSIS OF 20 CASES

Age incidence: 37–73 years.

Wassermann tests negative in all cases.

Sex distribution: 17 males—three females. The ten cases from the U. S. Veterans Hospital were, naturally, all males; so this does not give a true sex ratio.

Average duration of ulcers, 14 years:

Of these, two were of short duration.

One had varicose veins for ten years but ulcer for only six months.

One had varicose veins for "years," but an acute ulcer with infection of seven weeks' duration.

Follow-Up:

Twelve cases healed:

Six from the U. S. Veterans Hospital were discharged after ample observation to assure healing.

Six from the New York City Hospital stayed healed for three months to three years.

Two cases still under observation at the U. S. Veterans Hospital.

Two fair results from the New York City Hospital need further Unna paste boot treatment to relieve edema and superficial ulceration.

Three cases not followed:

Two left against advice when not quite healed.

One discharged healed.

Two failures.

CRITIQUE OF THE TWO INSTANCES OF FAILURE

Case 5.—C. B., New York City Hospital group: This was a male, aged 54, who was first admitted in February, 1934, with varicose ulcer of the left leg. He had three subsequent admissions. The ulcer kept recurring. The first Kondoleon operation was not extensive enough. A second Kondoleon operation was performed three months later. The leg was not grafted for six weeks. He left the hospital against advice, before the ulcers were completely healed, and has not been seen since. Failure was anticipated, because of poor after-care.

Case 11.—W. C., New York City Hospital group: This was a male, aged 68, who had had varicose ulcers for ten years, which repeated injections had failed to heal. The Kondoleon operation was followed by pinch-grafts in one week. He had two subsequent graftings, all of which healed sluggishly. The patient was discharged, healed, after two months. An Unna paste boot applied but not left on long enough. When seen, November 16, 1939, had large, deep recurrent ulcers on both legs. Arteriosclerosis was probably a factor in this case.

SUMMARY

Our follow-up is not as complete as we could wish—largely because the U. S. Veterans Hospital draws from other than the metropolitan districts and because the New York City Hospital has a very poor and migrant clientele. The hospitalization period at the U. S. Veterans Hospital is longer than would occur elsewhere, as the Government charges are kept until they are completely healed. They leave with a better chance of permanent cure than do the New York City Hospital cases.

We have had one severe failure, noted previously, and two cases that

have had slight recurrences that will need minor procedures to relieve the edema and superficial ulcerations.

In analyzing our failures there are three important causes that we hope to correct in the future:

(1) Incisions have not been long enough in some cases.

(2) There has been too long delay between the initial incision and secondary skin grafting. In a busy hospital service it is difficult sometimes to get operative time for skin grafting.

(3) Immediate follow-up as to treatment of the dermatitis following the grafting, and application of Unna paste boots or Ace bandages, has been incomplete in two cases.

The question can be raised as to whether there may not be late recurrences in our cases. We feel, from our examinations on discharge and follow-up, that the lack of edema in the foot and the return of the tissues to normal consistency promise a permanent cure and return these patients to active life with the greatest rapidity.

In observing cases treated by elevation, rest and wet dressings, we have not seen the above mentioned changes after they are up and around again.

DISCUSSION.—DR. A. G. BRENIZER (Charlotte, N. C.): These people we say have phlebitis, but do they have phlebitis or lymphangitis? If we do not do something for the lymphangitis, they will not heal. Doctor Bancroft has found out that certain of these cases of so-called varicose ulcer will not heal until a very radical operation, like a modified (not so extensive) Kondoleon, is performed. That operation was originally undertaken to reestablish a wider and more abundant anastomosis between the superficial and deep lymphatic vessels.

The speaker then showed photographs of a very extensive ulcer of the leg, which demonstrated splendidly an ulcer as big as two hands, covered with full-thickness Reverdin grafts. The leg was not even swollen (edematous) because it had been elevated and the graft-bed prepared for three weeks. Yet, later, when the leg was put to the floor and the edema returned, three-fourths of the grafts, after "taking," sloughed and were lost. Next, he showed a marked lymphangitis (elephantiasis), very much improved by the Rogers-Kondoleon-Sistrunk operation. He then demonstrated, by a series of photographs, the healing of grafts where the vessels were tied and sloughing where they had not been tied.

His point was: That though the blood vessels are tied or a complete or incomplete Kondoleon operation performed, the improvement comes from the relief of the lymphangitis rather than of the phlebitis.

DR. HUGH H. TROUT (Roanoke, Va.): There is a certain percentage of cases following such operations in which there will be recurrences. We have had this experience, and, recently, we have tried out a drug which is mentioned at every medical meeting nowadays, namely, sulfanilamide. We have had satisfactory results in two cases with its use. These recurrences are usually preceded by attacks of so-called "erysipelas"; then they get over one attack and then repeat, and then, after several such attacks, "elephantiasis" or an "elephantoid state" begins to develop. We had quite a few recurrences before the days of sulfanilamide but since then we have only had two: one a filaria with superimposed streptococcic infection, with attacks of fever

on an average of once a month; the other an uncomplicated streptococcic infection. The first case was two and one-half years ago. After putting her on sulfanilamide, for the first time we obtained a quick result as regards reduction of fever and the disappearance of the infection. She has taken sulfanilamide two or three times a month, which has apparently prevented the recurrence of these attacks. The other case is more recent and we cannot say much about it yet, but I can say we believe sulfanilamide is well worth consideration as a preventive of these recurrent attacks of streptococcal infections.

DR. M. STANLEY-BROWN (New York, N. Y.): The operative technic which has just been described is a comparatively simple one but the procedure as a whole is beset with pitfalls. Some of our poor results and failures illustrate this very well.

To begin with, the patient must be cooperative and willing to follow instructions for a period of six months or more. Great care must be taken in the selection of the cases. The City Hospital failure was a good example of this. There were impaired arteries along with varicose veins and edema, and the trauma of operation was more than the circulation could stand. The best time to operate is when there is the minimum of infection and edema. Whenever possible it is preferable to give the patient a period of bed rest, elevation, and wet antiseptic dressings before operation. Whirlpool baths, used during this period, are often of great assistance. Some of our delayed healing and failures of our grafting have been due to disregard of this principle.

At operation, one of the difficulties is profuse bleeding. The veins are held wide open in scar tissue and cannot be clamped easily. An Esmarch bandage may be used on the thigh to facilitate the procedure. If the incision is begun below and carried upward, the veins in the ankle may be easily ligated before they enter the scarred area, and excessive bleeding reduced.

When we first began to employ this operation, we used to remove a strip including skin, subcutaneous tissue and fascia for the entire length of the incision. This, however, is not necessary, as a single incision through the involved gapes open sufficiently to relieve tension and afford adequate drainage.

The incised area should be as clean as possible for skin grafting. A solution of 1:5,000 acriflavine is very nonirritating and cleans up granulations rapidly. Unless the field is very clean, pinch-grafts are the ones of choice, though occasionally in selected cases Thiersch grafts have been used with success. Immobilization of the extremity following grafting is of great importance and plaster of paris should cover from foot to midthigh. Grafting must be undertaken within a week after the initial operation.

I cannot emphasize too strongly the importance of immediate and late postoperative care. The patient should be kept in bed with moderate elevation of the leg until healing is complete. The leg should not be allowed to hang over the side of the bed, or the patient allowed to walk without the support of an Ace bandage, properly applied, or an Unna paste boot. Few of our patients have the intelligence to apply a bandage properly, so our best results have been with a boot. It requires from three to six months to restore circulation and proper lymphatic drainage, and during this period edema must be kept out of the leg. By this, further scar formation is prevented and the return of a normal consistency to the tissues, and a choice of permanent cure is assured.

The average hospitalization time of these cases is about two weeks before operation and six weeks to two months after operation. This may seem long, but with a history which averages 14 years of ulcer, which heals and breaks down repeatedly, and frequent periods of hospitalization, it is an economy of time in the end.

DR. HOWARD MAHORNER (New Orleans, La.): We have arrived at somewhat the same idea as Doctor Bancroft has in treating these cases, though from a little different angle. Several factors are responsible for keeping these ulcers open, which are: Back pressure; infection; and in long-standing cases, scarring. It is necessary to get rid of each one to cure the patient.

The speaker then demonstrated, photographically, a case with perfectly huge varicose veins. The leg was brawny and indurated in the lower part. If this area ulcerated and the ulcer remained open for any length of time she would have the same condition he described. Some years ago we started ligating these veins. The important thing is to ligate them high, but we found a number of cases that had additional leaks below the saphenous which are not affected by high ligation. Furthermore, we found that injections of sclerosing solution only, are not sufficient to hold back the pressure in these cases. For that reason we cut out segments of veins where these additional leaks from the deep to the superficial veins occurred. It was possible to foretell where the leaks were by certain tests. The "Comparative Tourniquet Test" will localize the level of incompetent communicating veins. In addition to high ligation of the saphenous vein and excision of segments of superficial veins into which communicating veins with incompetent valves permit additional backflow from the deep to the superficial system, where there is much scarring from long-standing ulceration, the ulcer bed is cut out and the area grafted with skin. In certain cases when there is much fixation, in removing varices below the knee, I excise indurated tissue around the veins even through the deep fascia and for the distance of the entire leg.

This is a very interesting and significant contribution Doctor Bancroft has made; an advance in treatment of these very difficult cases.

DR. ROBERT L. RHODES (Augusta, Ga.): If you will recall, at the White Sulphur meeting in 1923, I presented the subject of elephantiasis and its relation to focal infection and reported several cases of recurrences following the Kondoleon procedure. In one instance the recurrence was caused by infection of the tonsils, and pockets of pyorrhea around several teeth. He was promptly relieved by the removal of the foci of infection and remained well over a period of ten years, after which time he moved away and was lost track of. Another strikingly similar case was observed about one year later.

SEMILUNAR CARTILAGES*

FRANK P. STRICKLER, M.D.
LOUISVILLE, KY.

INJURY to the semilunar cartilage is one of the most common knee joint injuries. With increased industrial activities, auto accidents, football, baseball, basketball, *etc.*, every surgeon is seeing larger numbers of these cases. Quite a few general surgeons are operating upon these patients, and well they may, for after all, who is better fitted to open a knee joint than a general surgeon?

I have been interested in this subject for some time, and have seen a number of these cases. My interest progressed to such a degree that, for my own use, I have devised several instruments which have been of assistance in making the operation easier and reducing operative trauma, at least from my own viewpoint.

I have always been of the opinion that the accepted period of convalescence for these cases was too long, and that this period should be reduced. With these suggestions in mind, let us consider injuries of the semilunar cartilages.

The internal cartilage is far more frequently injured than is the external. There is an anatomic basis for this which I will not touch upon in this paper. The internal cartilage is injured and displaced when strain is put on the internal lateral ligament of the knee joint, with the knee flexed and the femur rotated inward. The internal semilunar cartilage is nearly always displaced inward; and as the cartilage is wedge-shaped, it may become jammed between the bones forming the knee joint, locking the joint and producing excruciating pain. When the internal cartilage is occasionally and rarely displaced outward, the protrusion can be palpated from the skin surface and the knee joint does not lock. Locking of the knee joint, however, is not always present in these cases, for in about one-third of the injuries to the internal semilunar cartilage, the history of locking is absent. This should always be kept in mind, and the absence of a history of joint locking does not mean there is no cartilage displacement or damage. Injury to the internal semilunar cartilage can also at times produce symptoms on the outer side of the joint; and it is well to recall that the external cartilage is not frequently injured.

When these patients present themselves, they usually give a history of a chronic knee condition with little or no mechanical treatment. If they have had mechanical treatment it has, as a rule, been so inadequate as to be of little or no value to the patient. The acute displacements of the internal cartilage, in a large number of instances, seem to be treated by a friend or an athletic coach, who gives the subject a yank on the leg and "calls it a day." The

* Presented before the Fifty-Second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

average patient has a superstitious horror of a surgeon looking into his knee joint. Consequently, the surgeon is the court of last appeal.

All of these patients should have their knee joints examined roentgenologically. Not that the roentgenogram will show the offending cartilage, but to rule out other conditions that could be mistaken for a displaced cartilage. However, some surgeons inject oxygen into the knee joint in an endeavor to show the cartilage. This may or may not be successful.

The physical findings in these patients are not remarkable. Injury to the internal semilunar cartilage is diagnosed by its acute onset, synovitis and swelling of the joint, locking of the knee joint, pain on the inner side of the patella localized over the internal cartilage. Occasionally there is palpable irregularity over the cartilage. There is also tenderness over the internal lateral ligament and tenderness over the cartilage when the knee joint is forced into extension. A history of the injury is also of help.

Symptoms of injury to the external semilunar cartilage are not as well defined as those of the internal semilunar cartilage. The patient complains of pain over the cartilage, and may feel something slip over the outer surface of the knee joint. There may also be a clicking over the outer surface of the knee joint on flexion or extension of the joint.

There are two types of treatment for displacement of the internal semilunar cartilage:

(1) *The mechanical treatment* (which should be followed in all acute cases), and by this I mean the ones seen immediately following the injury. The patient has severe pain with marked muscle spasm. Therefore, in reducing the dislocated cartilage, an anesthetic should be administered. The steps for reduction are *acute flexion, lateral deviation, internal rotation, and complete extension.* Following reduction, the knee should be immobilized for three weeks to give time for union of the cartilage to become established. At the end of this time, the patient should have massage, the shoe raised one-quarter of an inch on the inner border heel and toe to relieve the strain on the internal lateral ligament. The patient should also wear a knee brace or cage for several months, which further controls motion at the knee joint. By following this outline of treatment, acute cases are given a chance to heal without operation. The conservative treatment is time-consuming and cannot be hurried.

(2) In those cases which have run a chronic course, with much discomfort and disability, the *operative treatment* is indicated, and it is in these cases that we are especially interested. To give a better view of the interior of the knee joint during the operation, the patient is placed on the operating table with the knees flexed to a right angle hanging over the table. We employ tincture of merthiolate for the skin preparation, and make the skin incision through sterile gauze. The usual incision is made about 1½–2 inches long, and extends obliquely from the lower angle of the patella to the tibial margin. Thin gauze sponges are clipped to the skin edges of the wound with skin clips.

The most rigid aseptic technic is observed and nothing is touched with the fingers. Perfect hemostasis is also secured.

For working inside the joint, we use angulated hooks for grasping the cartilage, and a right angle angulated knife for cutting the cartilages free, also an angulated V-shaped knife with the cutting surface in the V. We also use angulated scissors, and have two sets of retractors adjusted to the proper angle,

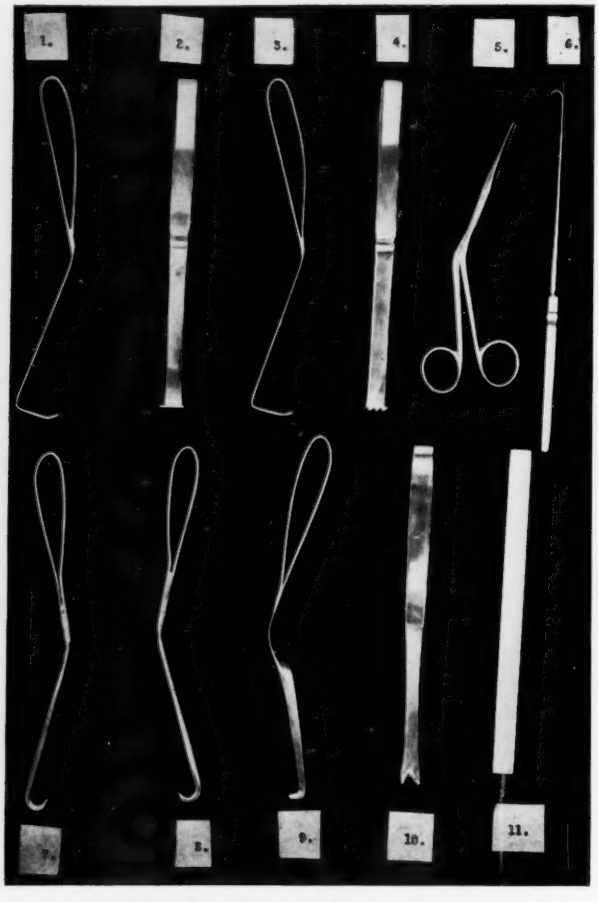


FIG. 1.—Illustrates instruments for operating upon the inside of the knee joint. Nos. 1, 2, 3, 4, are blunt and toothed retractors. No. 5—Angulated scissors. No. 6—Small hook for tags of cartilage. Nos. 7 and 8—Angulated hooks for larger cartilage tags. No. 9—Right angle knife. No. 10—V-shaped knife with the cutting surface on a V. No. 11—A flat or spatula retractor.

one pair blunt, the other with teeth. These instruments are not expensive, nor as complicated as they may seem (Fig. 1).

The joint capsule is opened, retractors properly placed, and the cartilage in question thoroughly examined. The cartilage may be found detached at either end, split, or detached in the middle along the internal lateral ligament, *etc.* The cartilage is grasped between the spatula or flat retractor and one of the hooks in order to firmly hook the cartilage. The cartilage is then com-

pletely removed with the angulated knives or scissors, leaving no fringes or tags. The wound is closed with interrupted sutures of fine chromic catgut in layers. In men, we pay no particular attention to skin closure. In women, we use a subcutaneous suture for the cosmetic effect. A compression dressing is applied, and the patient returned to bed with no splints of any kind. The knee is slightly flexed on a pillow, ice bags and small amounts of opiates are employed to control pain.

Twenty-four hours later, and never longer than 48 hours, the patient is out of bed walking with one crutch. We firmly believe that early walking and weight-bearing prevents adhesions in the joint, diminishes muscular atrophy, prevents joint stiffness, and makes a large amount of massage, diathermy, *etc.*, unnecessary; it also markedly cuts down the time of postoperative convalescence. Our cases are back at work in four or five weeks from the date of the operation.

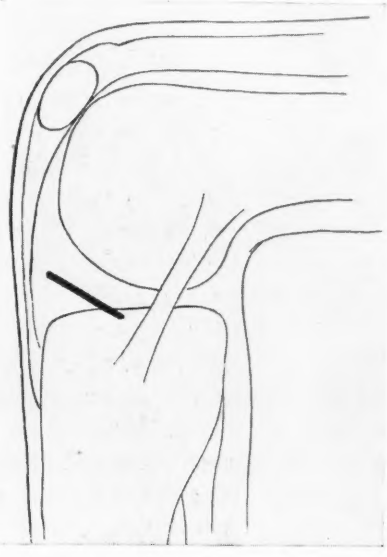


FIG. 2.—Schematic drawing of the knee joint showing the location of the incision; this incision in no way impinges on any of the important ligaments of the knee joint.

In reviewing the literature, I find that all sorts of plaster encasements, splints and braces are put on these patients postoperatively, and that knee joints are often immobilized anywhere from ten days to three weeks. This, I consider to be absolutely unnecessary. After all, no important anatomic structures of the joint are involved other than the capsule and the cartilage. The ligaments are never disturbed, and the strength of the joint should never be impaired by this operation.

SUMMARY

This paper has been presented to call attention to the postoperative treatment of semilunar cartilages, in order to demonstrate that the convalescence of these patients can be shortened; also, to present instruments that facilitate the removal of the semilunar cartilage without damage to the joint surfaces or its synovial membrane, as, in my opinion, operative trauma definitely plays its part in postoperative discomfort, delayed convalescence and poor results.

THE USE OF PRESERVED CARTILAGE IN EAR RECONSTRUCTION*

HAROLD L. D. KIRKHAM, M.D.

HOUSTON, TEXAS

THE RECONSTRUCTION of ears, either partial or total, has long been one of the most disappointing and unsatisfactory branches of plastic surgery. This is due in large measure to the complicated form of the ear cartilage or scaffold, making it extremely difficult to carve and pattern rib cartilage so that it will be thin enough and light enough to preserve the normal position and appearance of the new ear. Rib cartilage has been employed because of the unavailability of elastic cartilage in large enough amounts and shapes. It is obvious from this premise that the chief difficulty in ear reconstruction has been to obtain a suitable scaffold or mold upon which to reconstruct an ear. If any thin, light reproduction of ear cartilage could be formed, even though a foreign body, and used as a foundation, the reconstruction would be simplified and the ultimate result should have a more pleasing cosmetic appearance. What better mold could one use than ear cartilage itself, if, when transplanted, it would remain as cartilage and remain *in situ*.

Some years ago the author became interested in the fate and behavior of transplanted rib cartilage, which occupies an unique position as regards its life and existence. For many years the excess costal cartilage removed in the course of a plastic reconstruction has been stored by burying it in a subcutaneous pocket in the abdominal wall, and here it remained indefinitely, and intact, for such future use as might be necessary. Despite the opinion of some authorities that much transplanted cartilage, in time, becomes absorbed or fibrosed and converted into fibrous tissue, studies of this transplanted cartilage, as shown in Figures 1 and 2, have definitely convinced the author that this is not true, but that cartilage remains permanently as cartilage.

The behavior of transplanted cartilage in remaining as such led to the belief that cartilage might be transplanted after death, and still retain its character, which, if true, would solve some of the difficulties of ear reconstruction. It was necessary to determine: (1) Is the behavior of elastic cartilage identical with the behavior of rib cartilage? (2) Could elastic cartilage be employed as a heterogenous graft? (3) If it could be employed as a heterogenous graft after death—how long after death would this be possible? Accordingly, a series of experiments were performed upon rabbits to answer these questions.

Rabbit A was killed, and one hour after death five pieces of ear cartilage were removed. Two of these were placed on ice dry, and two on ice moist in Ringer's solution. The fifth piece was planted in the abdominal wall of Rabbit B. Each hour thereafter another piece of ear cartilage was removed

* Read at the Fifty-second Annual Meeting of the Southern Surgical Association, Augusta, Ga., December 5, 6, 7, 1939.

from Rabbit A and planted in the abdominal wall of Rabbits C, D, E, F and G, respectively. At the end of 24 hours a piece of wet and dry ice-box cartilage was planted in Rabbit H, and at the end of 48 hours this was repeated in Rabbit I. These rabbits were watched for a period of six months, one however, dying in the interim; namely, the three-hour rabbit. After six months

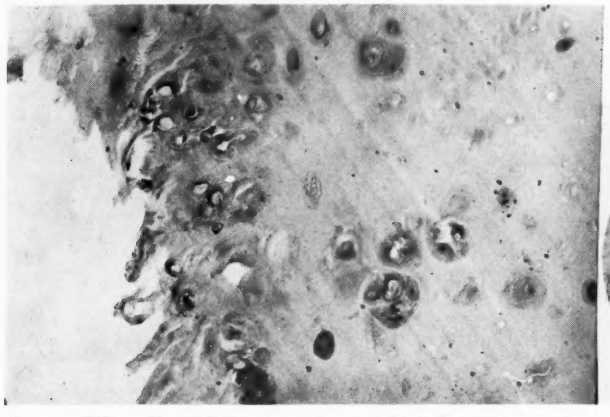


FIG. 1.—Rib cartilage after autogenous transplantation for ten years.

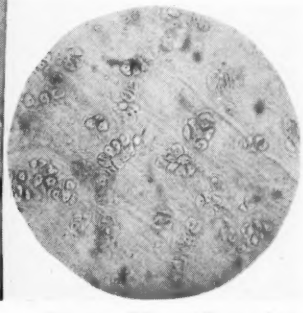


FIG. 2.—Rib cartilage after autogenous transplantation for eight years.

the wounds were opened, the cartilage removed and sectioned (Fig. 3), and with the exception of the dry, iced cartilage all were intact, and showed the characteristics of cartilage, though the cell spaces were vacuolated, the nuclei having disappeared, and the cartilage dead. This answered the three ques-

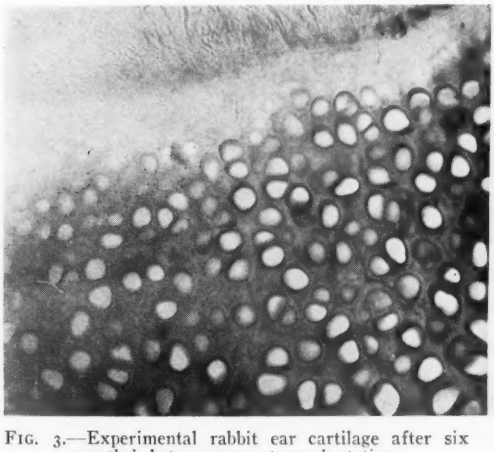


FIG. 3.—Experimental rabbit ear cartilage after six months' heterogenous transplantation.

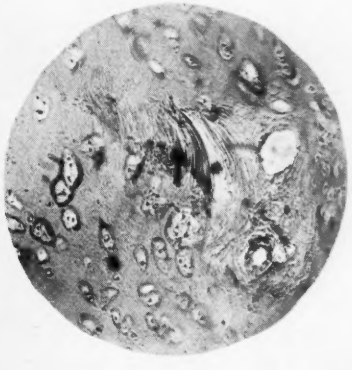


FIG. 4.—Preserved rib cartilage after two years' transplantation.

tions to be determined in the affirmative, establishing the fact that heterogenous cartilage grafts remain as cartilage, the cartilage retaining its form even though cellular death has occurred.

Shortly after this an ear cartilage was removed from a person soon after death and transplanted into the abdominal wall of another individual, with the

idea of employing it later to reconstruct an ear. One year later this cartilage was distinctly palpable under the skin, but unfortunately the patient drifted away and it was never possible to obtain microscopic sections of it or to complete the reconstruction. About this time the author became acquainted with the splendid work being done by O'Connor and Pierce[1] on preserving excess

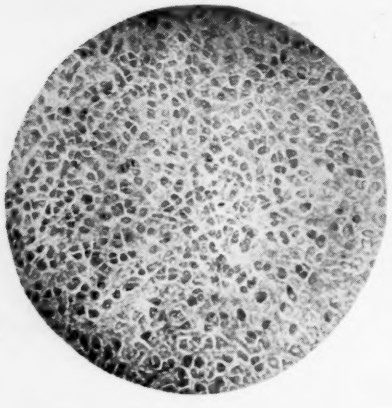


FIG. 5.—Preserved ear cartilage after two years' transplantation.

FIG. 6.—Preserved ear cartilage after four years' transplantation.

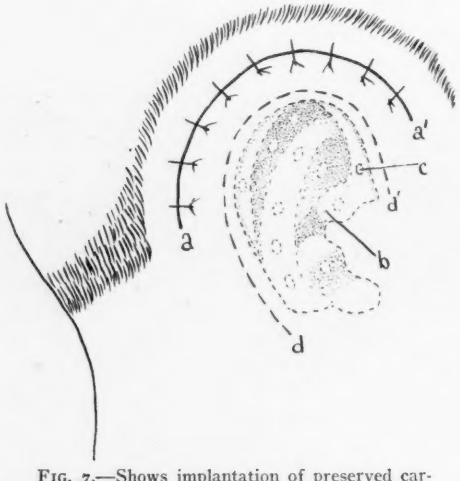


FIG. 7.—Shows implantation of preserved cartilage. (a a') Represents incision in the hair line. (b) Shows ear cartilage placed under skin flap. (c) Represents puncture holes through the cartilage for anchorage. (d d') Shows line of incision for the second-stage operation.

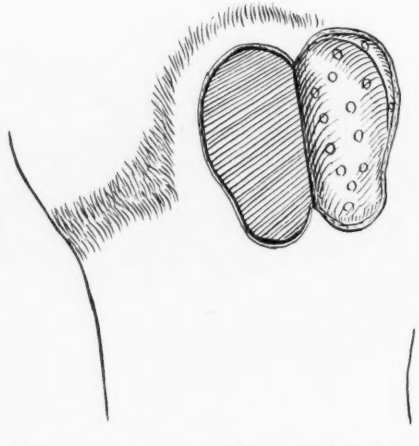


FIG. 8.—Shows the implanted cartilage with its skin covering raised and brought forward, leaving a raw surface behind the new ear, and over the mastoid region. This is covered with a free stent skin graft.

rib cartilage indefinitely, and its satisfactory employment in various reconstructive procedures, and all credit should be given them for the valuable adjunct to plastic surgery this procedure has advanced. Since their work, not only experimentally but clinically, has shown that the employment of preserved rib cartilage is practicable, why should not the same hold true of

ear cartilage? Clinical experience has shown that ear cartilage behaves in the same manner, and thus it can be collected, preserved and stored for future use, and employed as a scaffold upon which to build a new ear. Pierce and O'Connor have found the most satisfactory preservative to be a solution of

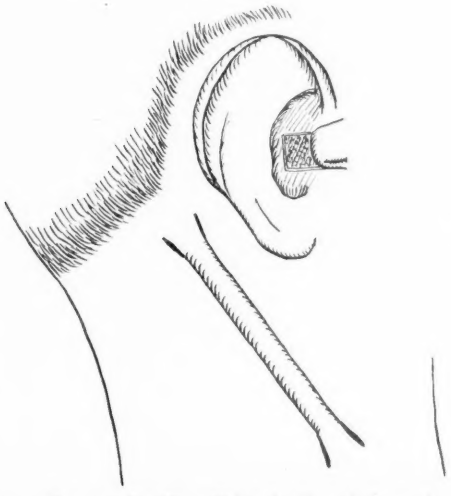


FIG. 9.—Double pedicle-tube flap of the neck. At the same time a flap of skin is turned on itself to form the new tragus, which procedure deepens the davum and concha. The resulting raw area is covered with a free skin graft.

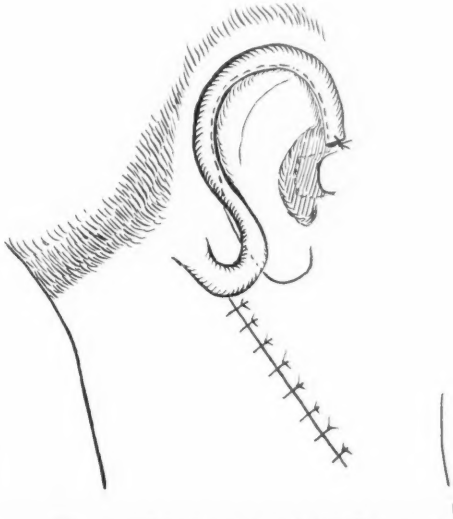


FIG. 10.—Lower end of tubed pedicle raised, and attached to crus of helix. Tube opened and draped over the ear to form the helix.

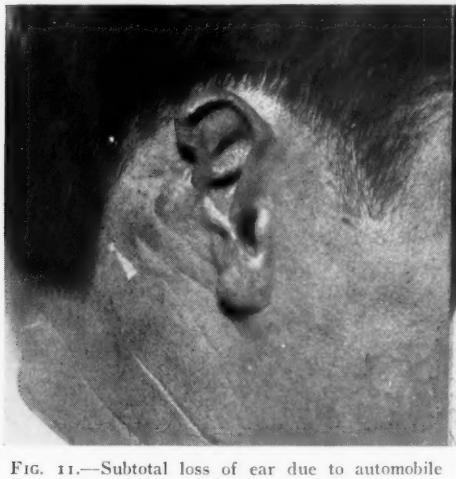


FIG. 11.—Subtotal loss of ear due to automobile injury.

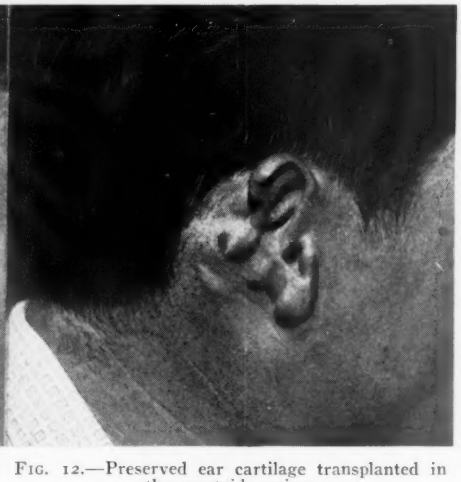


FIG. 12.—Preserved ear cartilage transplanted in the mastoid region.

aqueous merthiolate in normal saline, 1 :4, and kept on ice. The solution, however, should be changed about every week or ten days.

In the employment of ear cartilages from cadavers, it is found that they are often too soft and pliable, but this can be overcome by soaking for two or three days in a solution of formalin before being placed in the merthiolate.

This method is also applicable in the case of automobile or other injuries where part of the ear is completely severed and the piece can be found. In these instances the skin is removed and the cartilage stored in the usual manner until such time as the ear reconstruction is deemed advisable. Since

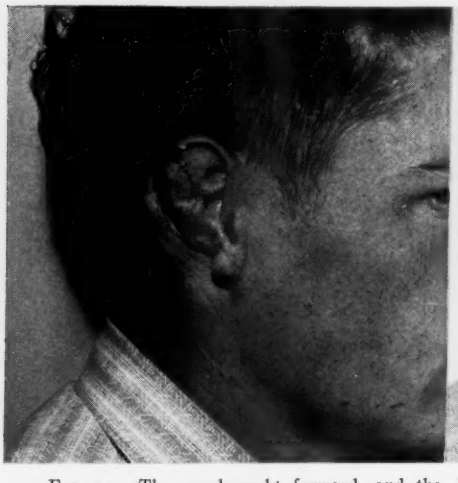


FIG. 13.—The ear brought forward, and the back of the ear and mastoid covered with a stent free graft.

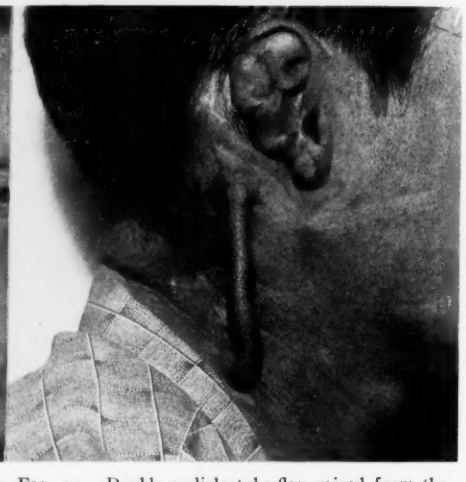


FIG. 14.—Double pedicle tube-flap raised from the neck.

these cartilages are essentially foreign bodies, and consequently may become loose from the surrounding tissue, it has been found that perforating the cartilage with small holes before it is planted allows granulation tissue from

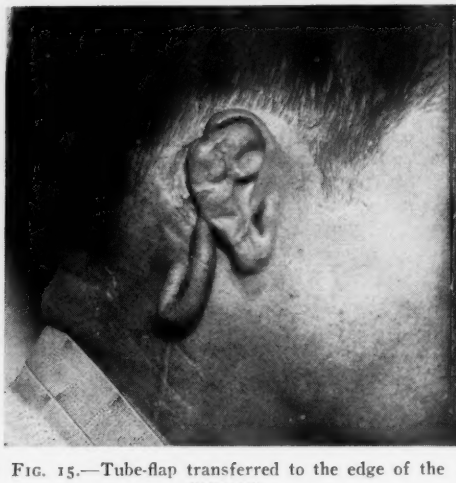


FIG. 15.—Tube-flap transferred to the edge of the new ear.

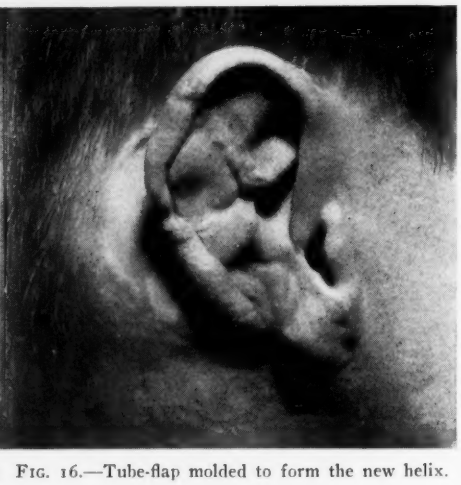


FIG. 16.—Tube-flap molded to form the new helix.

both sides to pass through the perforations, and in this way acting as rivets to hold the cartilage in place.

The reconstruction of the ear is accomplished in about five stages. At the first stage the cartilage, which has been previously perforated, is planted

under the skin of the mastoid area through a curved incision high up in the hair line. In about two months the cartilage, with the skin of the mastoid region, is raised, thus bringing the new ear forward, leaving a raw surface over the mastoid and back of the new ear. This area is covered with a thin split-graft placed on a molded stent. At a later date a double pedicle tube-flap is made on the neck, about the size of a lead pencil, and long enough to be carried over the ear. In about three weeks the lower end of the flap is transferred to the edge of the new ear, and in three more weeks the draping of the flap around the new ear to form the helix is completed, and the excess removed or returned to its bed. If no tragus exists this can be constructed by infolding a flap of skin on itself and the resulting raw area covered by a free graft, and this procedure at the same time deepens the concha.

Having employed this method in ear reconstruction during the past few years, in only one has there been a loss of the cartilage, and this resulted from an infection in the graft bed which might have occurred by the use of an autogenous graft. It is believed that ears so reconstructed, with a normal ear scaffold, are more sightly and satisfactory to the patient and surgeon alike.

REFERENCE

[1] O'Connor, G. B., and Pierce, G. W.: Refrigerated Cartilage Isografts. Surg., Gynec., and Obstet., **67**, 796–798, December, 1938.

DISCUSSION.—DR. VILRAY P. BLAIR (St. Louis, Mo.): No one who has never tried to make an ear can appreciate the value of this contribution. We have attempted many of them in some other way, and our results recommend this method most strongly. In using a shell of cartilage of somewhat the size and shape desired, cut from the surface of the anterior costal junctions, you can make something that will stand out, give it the general outline of an ear, and in this way get by, because nobody looks at an ear, but will note its absence four blocks away. Another thing that makes this timely is that, until recently, we were never called upon to restore a girl's ears, but they are now exposing these last of hidden things. I think one point is worthy of discussion. Possibly the outstanding contribution of the paper is the removal of a piece of live cartilage from a dead body before changes have occurred, and then burying it in the abdominal wall of the patient who is going to be the recipient. That would give you time to study the recipient's tissue reactions. A suggestion along this line has been made by Gillies—that is, to dissect out the mother's cartilage and use it as the form upon which to build the child's ear. I was more impressed with this suggestion after seeing some patients of Dr. Paul K. Greeley's, in Chicago, upon whom he was carrying out this plan. There is probably no advantage in using the mother's cartilage other than that it is available. One thing I noted in the mother was that there was little deformity after removing the cartilage, merely a little lopping over of the ear, and that can be taken care of by slipping in a little bit of her costal cartilage. One tremendous advantage in using human ear cartilage is that it permits early restoration. A great deal of psychic damage can be done by having a child teased about the deformity. No matter what cartilage is used, if you can put it over, I should say it probably should be done before the age of five, and that is a tremendous advantage.

Doctor Pierce and Doctor O'Connor did a good deal of work with preserved costal cartilage.

Dr. John Staige Davis (Baltimore, Md.): I have been much interested in Doctor Kirkham's report. I have been using cartilage transplants for a great many years, and recently have gone back to trying isocartilage again. My feeling is that if it is possible to obtain autogenous cartilage I think it ought to be used. The difficulty with isocartilage, which has been preserved, is that you never know when the reconstruction, which you have built with the preserved cartilage, will begin to absorb. Some of the transplants last over long periods of time, and others absorb quite quickly. I seldom use large pieces of preserved cartilage, but have found it useful for filling out small areas. I prefer, in reconstructive work, autogenous cartilage which is fresh, or has been stored under the skin for as long as it is convenient.

Dr. H. L. D. Kirkham (Houston, Texas), closing: I want to thank Doctor Blair and Doctor Davis for this discussion. Undoubtedly the use of fresh cartilage is very much superior, where it can be obtained, to the use of any preserved cartilage. Also, if you get fresh cartilage from a body that has just died, as we did in our first experimental work and in the first case with the child, that would be preferable, but the objection is that whenever you have an ear to reconstruct such cartilage is seldom available. Another objection to fresh cartilage is that when you put the fresh cartilage under the skin, and it is later taken out, it has become attached to the surrounding tissue and you have a piece of thick fibrous tissue—scar tissue which has thickened up—and I do not think you get such a thin ear in the final result.

MEMOIRS

WILLIAM THOMAS BLACK

1875–1938

THE LIFE of Dr. William Thomas Black, which began in Stanton, Tennessee, January 13, 1875, came to a close in Memphis, Tennessee, December 10, 1938. His passing was sudden, the result of a heart attack during the performance of an operation; thus, it was granted to him to pursue to his last hour the work he loved so well.

WILLIAM THOMAS BLACK, M.D.

Doctor Black's early education was received in public schools, and his premedical training from private tutors. He obtained his degree in medicine from the Memphis Hospital Medical College, later the University of Tennessee Medical College, in 1898, and following his internship, attended surgical clinics in Philadelphia, New York, Boston and Chicago.

At the beginning of his career, Doctor Black practiced general surgery for several years, and in this field achieved an enviable reputation. His real

interest, however, was in gynecology, and he, therefore, gradually abandoned general surgery in favor of this specialty. Through his intense devotion to his work, his capacity for painstaking research, and his numerous writings, he was soon recognized as one of the leading gynecologists of the country, and accordingly was the recipient of many honors. His professional affiliations included memberships in the American College of Surgeons, the American Board of Obstetrics and Gynecology, the American Association of Obstetricians and Gynecologists, the Southeastern Surgical Congress, the Central Association of Obstetricians and Gynecologists, the Tennessee State Medical Association, and the Southern Surgical Association. Of the last three, he had in former years held the office of Vice-President. He also organized and was the first Chairman of the Section on Gynecology of the Southern Medical Association. Doctor Black was a popular speaker at medical meetings; his papers were always stimulating and informative, displaying a complete grasp of his subject.

Soon after the completion of his medical training, Doctor Black was made a member of the faculty of his alma mater. He served faithfully in this capacity for more than 30 years, taking an active part in the affairs of the institution both before and after its absorption by the University of Tennessee, and progressing from one appointment to another. Several years before his death he was elected Chief of the Department of Gynecology of the university. With this appointment, he also became Chief of the Department of Gynecology at the John Gaston Hospital. In addition, he was visiting gynecologist to the Baptist Memorial Hospital, consulting gynecologist to St. Joseph's Hospital, and visiting gynecologist to the Shelby County Almshouse.

We who knew Doctor Black best remember him best as a confrere, thorough in investigation, conservative in judgment, conscientious in counsel, and skillful in the practice of his art. If one should be called upon to name his most outstanding characteristic, however, one would probably say it was his conscientiousness in all matters pertaining to his work. He was keenly aware of his obligations as an instructor at the university, throughout the years never failing to appear in the classroom and clinic except under the most urgent circumstances, and always bringing to his teaching the same interest and thoroughness which he exhibited in his other professional activities. Also, in all his ministrations to his patients, he was guided by a profound sense of responsibility, advising according to his best judgment and rendering service to rich and poor alike, regardless of the cost to himself.

We cannot recall that Doctor Black had any particular hobbies. He was fond of hunting and fishing, but seldom took occasion to indulge in these pleasures. Rather, so absorbed was he in his work that he spent most of his vacations in some endeavor connected with the profession.

In looking back over a long acquaintanceship with Doctor Black, it is pleasant to dwell upon those hours of relaxation when, after a meeting, across the luncheon table, or at some social function, we had the privilege of enjoying his genial companionship and his entertaining conversation. He was the

fortunate possessor of a most engaging personality, which made his presence welcome in any gathering.

Doctor Black was married in 1902 to Flora May Grehan, of Appleton, Wisconsin. She, with two daughters and one son, Dr. William Thomas Black, Jr., survive him. In his going, they lost a devoted husband and father, his friends lost a delightful companion, and the profession lost an able and respected member, a worthy exponent of its best traditions.

ROBERT L. SANDERS

FRANCIS HENRY HAGAMAN

1896–1939

THE SUDDEN DEATH of Dr. Francis Henry Hagaman in an automobile accident on the morning of August 19, 1939, while he was hurrying to the

FRANCIS HENRY HAGAMAN, M.D.

bedside of a patient, was a deplorable loss to American Surgery. That it occurred during the performance of duty to the suffering was in keeping

with the selfless devotion of Doctor Hagaman to the relief of human pain, the alleviation of human sorrow. The keynote of his character was duty to men and to his Divine Maker. But his feeling went beyond the dictates of duty; it extended through gentlest consideration to deep and tender love. To noteworthy skill as a surgeon, he added that crowning achievement of character—heartfelt sympathy, the precious balm for all wounds, whether of body or of spirit.

Doctor Hagaman was of the notable Dutch stock that emigrated from Holland to New York in the early days of American history and that has furnished our country so many of its admirable citizens. The original Hagamans came to the colony of New Amsterdam about 1650; later descendants of the family moved to Somerset County, New Jersey, settling near Flemington. In subsequent times, a branch of the Hagamans came South, selecting as their home Centreville, Mississippi, where, on August 19, 1896, the subject of this memoir was born, the eldest of the four children of Dr. R. L. Hagaman and his wife Vernon Darden Hagaman, his sire contributing to his son a passion for service to humanity through the profession of medicine.

He attended the grammar and high schools of Centreville, from which he was graduated in 1911. He spent the academic year of 1912–1913 in attendance at the College of Arts and Sciences, Tulane University, where his study was devoted to premedical work. During the summer of 1913 he took a business course. After its completion he worked as a clerk for the Corr-Williams Tobacco Company, Jackson, Mississippi, until the fall of 1914. He then entered the Tennessee College of Medicine at Memphis, where, in 1916, he completed the first two years of the medical course. From 1916 to 1918, he studied in the Medical College of Tulane University, from which he was graduated with the degree of Doctor of Medicine on June 5, 1918.

On July 12, 1918, he enrolled for Naval Service at Raymond, Mississippi, and served as Lieutenant, Junior Grade, Medical Corps, U. S. Navy. His active duty dated from November 6, 1918, to December 15, 1919, when he was honorably discharged. The period of his active duty was partly spent at Washington, D. C., where he was attached to the Naval Medical School during the influenza epidemic of 1918. At the time of his discharge he was stationed at the Naval Hospital, Gulfport, Mississippi, but was enrolled in the Naval Reserve Force until September 30, 1921.

In January, 1920, he took up the general practice of medicine in Sardis, Mississippi. On October 31, 1920, he was married to Edwina Short at Centenary Methodist Church, St. Louis, Missouri. Her wit and charm constituted for him a never failing source of happiness.

He served as Assistant Superintendent of Mississippi Charity Hospital, Jackson, Mississippi, from January, 1922, to March, 1925, when he want to New York City, where he served as a resident in the Hospital for Ruptured and Crippled Children. There he came under the influence of Dr. Royal Whitman, whose famous technic he admiringly adopted as a model in his own subsequent practice. In May, 1926, he returned to Jackson, Mississippi,

where on July 1, 1926, he formed a partnership with Dr. H. R. Shands, a connection which was continued until his death. He was elected to membership in the Southern Surgical Association in 1936.

He is survived by his widow and by a son of 17, who gives every promise of worthily emulating the character of his lamented father.

The tragic taking-off of Dr. Hagaman at the early age of 43, prevented the harvest of a widespread fame that would have resulted, in due time, from a more extended recognition of his skill, expertness, and versatility in the varied fields of surgery to which he devoted himself with untiring application and ceaseless energy. His main interest at the end, as at the beginning, of his practice was in orthopedics, in which branch of work he had no superior in the state of Mississippi. The most precious dream of his life was to render the utmost possible service to crippled children. His successful treatment of them, during the decade of his connection with the Mississippi Baptist Hospital at Jackson, contributed not only immeasurable benefit to his patients but also illuminating inspiration to the members of the profession.

To provide the needed recreation of physical strength strained by arduous devotion to his labors, he adopted as his hobbies photography and horseback riding. In both of these he became, for an amateur, exceptionally accomplished, so deeply ingrained was thoroughness as an element of his character.

The untimely demise of Doctor Hagaman bereaves the profession of surgery of a skilled, conscientious, scientific practitioner; the State of Mississippi, of an estimable citizen; his church, the Presbyterian, of a faithful parishioner; his family, of a dearly beloved husband and father; and the Association, of a most worthy member—tireless, patient, skilled surgeon that he was, friend to all living things, a servant of life itself. Need more be said?

HARLEY R. SHANDS

REGINALD H. JACKSON

1876–1939

IN THE DEATH of Reginald H. Jackson, the medical profession lost one of its most distinguished members, and Wisconsin one of its most revered

REGINALD H. JACKSON, M.D.

citizens. Doctor Jackson possessed, to an unusual degree, those qualities of mind and heart that endeared him to all those with whom he came in contact.

Perhaps his outstanding characteristic was the tenderness with which he approached his surgical duties.

He despised mediocrity and never tired in his quest for knowledge, yet his greatest joy was the alleviation of the suffering of his patients. Doctor "Reg," as he was fondly called by his friends, was always a true and loyal friend, a counselor, a student as well as a teacher. He was a great student of pathology and always insisted on a personal study of the gross and microscopic specimen on the completion of an operation. At the operating table, he insisted that tissues be handled with extreme gentleness and care.

Perhaps his outstanding professional attainment lay in the originality of his contributions to both the fields of medicine and surgery. His keen diagnostic sense was always the last court of appeal for his associates. As such, he inspired the highest confidence in all who knew him.

Doctor Jackson was keenly interested in the betterment of the medical profession and always supported its highest ideals. He made numerous contributions to the medical literature and the many scientific papers he presented to the various medical societies are evidence of his intense interest in his work. He was a member of his County and State Medical Associations, serving as president of the Wisconsin Medical Society in 1933; American Medical Association, the Southern Surgical Association, the Western Surgical Association, of which he was president in 1935; and of the American College of Surgeons.

Reginald Henry Jackson was born January 17, 1876, in De Pere, Wisconsin, and was the third generation of surgeons in his family. His father, the late Dr. James A. Jackson, and his grandfather, Dr. Joseph Hobbins, came to Madison from England in 1853. His mother was Josephine Hobbins Jackson.

When Doctor Jackson was a small child, his family moved to Madison where he had since made his home. He began in his youth to work with his father, then one of the pioneer surgeons of Wisconsin.

After completing his academic studies at the University of Wisconsin, Doctor Jackson went for his medical training to the College of Physicians and Surgeons at Columbia University, New York City. After his internship he became house surgeon at the Presbyterian Hospital in New York. After his return to Madison, he became impressed with the clinic idea and with his father and brothers, James and Arnold founded the Jackson Clinic. He served as head of the Clinic and was Chief-of-Staff of the Methodist Hospital until the time of his death.

Doctor Jackson married Elizabeth Breese Stevens, June 4, 1908. Their only child, Dr. Reginald Jackson, Jr., had for the past three years been his father's assistant and is continuing on the staff where his father served so skillfully and with such tireless energy and idealism.

ROBERT L. PAYNE

WILLIAM BATTLE MALONE

1874–1939

WILLIAM BATTLE MALONE, a Fellow of the Southern Surgical Association since 1916, and Vice-President in 1923, was born July 4, 1874, at Browns-

WILLIAM BATTLE MALONE, M.D.

ville, Tennessee, and died on September 4, 1939, at Memphis, Tennessee.

After graduation from Webb's Preparatory School at Bell Buckle, Tennessee, he completed the classical course at Vanderbilt University, receiving

the A.B. degree, *cum laude,* in 1896, and the M.D. degree from the University of Tennessee College of Medicine, in 1899.

After serving his internship in New York, in 1900, he returned to Memphis and became associated with the late Dr. William B. Rogers, a distinguished teacher of surgery of that period, who exerted a profound and lasting influence upon his students and whose mantle fell upon the shoulders of Doctor Malone, who succeeded him as Professor of Surgery in the University of Tennessee College of Medicine, in 1913. He was a most worthy successor and disciple of this great surgical pioneer, carrying on his high concepts of professional duty and skill which mark, always, the Master Surgeon.

At the outbreak of World War, Doctor Malone was commissioned Major in the Medical Corps of the Army. Serving overseas with the A.E.F., he was awarded the Distinguished Service Medal "for exceptionally meritorious and distinguished services as chief of surgical teams in hospital formations at the front through all combat activities of the American Expeditionary Forces from the Cantigny offensive to the close of the Meuse-Argonne offensive."

Always a leader in organized medicine, giving freely of his time and talents, Doctor Malone was a past president of the Memphis and Shelby County Medical Society; a past president of the Tennessee State Medical Society (1928); a past president of the American Association of Railway Surgeons (1917); a Fellow of the American College of Surgeons; and Vice-President of the Southern Surgical Association (1923).

Long will he be remembered and revered because of his contribution to the organization and development of the Methodist Hospital, of which he was Chief-of-Staff from its founding in 1921. To those of his confreres who knew him, the Methodist Hospital will always be a memorial to his genius and an expression of his love for suffering humanity.

William Battle Malone, to the manor born, represented all that was ethical in the profession—kindly, loyal and honest. Loved by those who were privileged to know him well, respected by all for his sterling traits of character, a gentleman and Master Surgeon, his like will not pass this way again soon.

Well may it be said of him:

"His life was gentle; and the elements
So mix'd in him that Nature might stand up
And say to all the world, *This was a man!*"

JOHN LUCIUS MCGEHEE

EDITORIAL ADDRESS

Original typed manuscripts and illustrations submitted to this Journal should be forwarded prepaid, at the author's risk, to the Chairman of the Editorial Board of the ANNALS OF SURGERY

Walter Estell Lee, M.D.
1833 Pine Street, Philadelphia, Pa.

Contributions in a foreign language when accepted will be translated and published in English.

Exchanges and Books for Review should be sent to James T. Pilcher, M.D., Managing Editor, 121 Gates Avenue, Brooklyn, N. Y.

Subscriptions, advertising and all business communications should be addressed

ANNALS OF SURGERY
227 South Sixth Street, Philadelphia, Pa.

ABSTRACTS OF PAPERS OF THE 1940 MEETING OF THE AMERICAN SURGICAL ASSOCIATION

SYMPOSIUM

FLUID AND ELECTROLYTE NEEDS OF THE SURGICAL PATIENT

The Structure of the Blood in Relation to Surgical Problems

John P. Peters, M.D. (by invitation). The proper conduct of the physiological processes of the body requires that the composition as well as the volume of the fluids in the body be maintained. The components that require the greatest consideration are the salts, which maintain the osmotic pressure and determine the distribution of water between cells and the interstitial fluids. Operative procedures are peculiarly prone to disturb water and salt relations and therapeutic efforts have often enough not been directed towards the restoration of natural conditions. Too much emphasis has been laid upon the restoration of fluid volume rather than composition, and often salt depletion has been exaggerated by methods that wash salt from the body and administration of excessive quantities of fluids without salt. The nutrition of the patient is too often neglected with the result that patients develop protein deficiencies which lead to edema. Case reports will be used to illustrate these errors and also to outline methods of treatment by which they may be avoided.

The Preservation of Blood

David C. Bull, M.D. (by invitation), and Charles R. Drew, M.D. (by invitation). The intelligent use of preserved blood requires knowledge as to wherein and to what extent it differs from fresh blood. To this end certain observations have been made on the changes taking place in the cells and the electrolytes. The white cell and platelet counts fall 50 per cent or more in the first two or three days but the erythrocyte count remains little changed for a month though the individual cell shrinks and much of its hemoglobin is to be found in the plasma. An important factor in the degeneration of the cells is their loss of potassium by diffusion into the serum. This phenomenon is hastened by trauma but is little influenced by the type of preservative or container. Though the plasma potassium rises as much as tenfold and potassium is definitely a toxic substance, the transfusion of preserved blood should be safe on this score except perhaps when large amounts of blood are given rapidly in conditions involving hyperpotassemia. The variations in the other electrolytes are of interest physiochemically rather than clinically.

The Plasma Proteins of Preserved Blood

John Scudder, M.D. (by invitation). Factors governing the cellular elements, electrolytes, hydrogen ion concentration, lactic acid, and blood sugar in preserved blood have been investigated. This communication deals with the proteins. In plasma there are five main proteins: albumin, alpha, beta and gamma globulin and fibrinogen. Their total concentration amounts to around seven per cent. Citrated blood was stored for

varying lengths of time in a refrigerator. Samples of the plasma were removed and after dilution and dialysis for 48 hours were placed in a Tiselius apparatus. As the different components of the plasma move with different speeds when subject to an electric current, a photograph may be taken showing these different proteins. From these pictures the total as well as the individual amounts of the different proteins may be obtained. Certain preliminary remarks may be made. Post mortem plasma is definitely abnormal. Lyophilized serum under the present methods of manufacture, reveals certain disturbances. Plasma from normal individuals when stored in proper shaped flasks and kept in an ice box, shows less denaturation than when stored in large flasks at room temperature. Reactions in plasma transfusion may be minimized by giving heed to these simple precautions.

Sodium Chloride Metabolism of Surgical Patients

Walter G. Maddock, M.D. (by invitation). Disease of or operations upon the alimentary tract often interfere with the normal intake of sodium chloride, and at the same time may cause abnormal losses of this important electrolyte. The need for replacing these losses has been well established and is better carried out with a knowledge of sodium chloride metabolism. Facts pertinent to the simple handling of this problem in surgical patients are presented.

Loss of Fluid and Salt Associated with Suction Drainage of the Gastro-Intestinal Tract

Grover C. Penberthy, M.D., and (by invitation) J. Logan Irvin, Ph.D., and R. Mayo Tenery M.D. The importance of supplying sufficient fluid, electrolyte and nutrition to patients during suction drainage applied to the gastro-intestinal tract has been frequently stressed. The difficulty of supplying adequate fluids, salt and food by the oral route to patients with a tube draining the stomach or duodenum is self evident and in addition the loss of fluid and salt from aspiration of stomach and duodenum makes adequate replacement by other routes important. The fluid lost through suction drainage at the ileum even when great, may be replaced through increase in the oral intake. Nutrition and fluid requirements can be maintained more easily, the lower the suction is applied. Regardless of the position of the tube during suction drainage, adequate intake-output studies are important to prevent dehydration. The regulation of intake to meet body needs through hunger and thirst is more likely in the case of drainage from the ileum than from the duodenum.

Plasma Loss in Acute Intestinal Obstruction

Jacob Fine, M.D. (by invitation). Continuous distention of the small intestine in the dog produces a fatal loss of plasma volume. Studies on the mechanism involved show: (1) that this is a phenomenon specific to the small intestine and does not occur when the colon, gall bladder and other hollow organs are distended, (2) that it is not due to dehydration, (3) that it is not due to distention of the peritoneal cavity, since short distended loops also produce a marked fall in plasma volume. Decompression of the intestine stops the loss of plasma and facilitates its return to the circulating blood. Desoxycorticosterone also inhibits the loss of plasma due to distention of the small intestine. Preliminary clinical studies confirming some of the above observations have been made. Experimental studies will be presented dealing with the effect on plasma volume of extraperitonealizing the distended intestine and of excluding the circulation of the intestine from the general circulation.

Plasma Loss in Shock as Effected by Therapy

A. S. Minot, Ph.D. (by invitation). Consideration of not only the quantity of fluids lost but also of the quantity and type of electrolytes lost with fluid in a given patient is necessary for successful replacement therapy. Too rapid or too liberal administration of fluid and electrolytes may lead to complications which at times are as serious as those which arise from failure to supply them in sufficient quantity. In patients in a poor state of nutrition or in whom there is either localized or general injury to capillaries, it is particularly difficult to maintain the proper distribution of administered fluid. Massive edema may occur while the blood stream remains dehydrated or even becomes progressively more dehydrated. Under these conditions the administration of colloid is an indispensable factor in the restoration of fluid and electrolyte equilibrium.

Hypoproteinemia and Its Relation to Surgical Problems

I. S. Ravdin, M.D. The serum proteins are the major factor in keeping fluids in blood vessels. Too much attention has been paid to the administration of water and salts and not enough to the forces that keep these in blood vessels. Certain profound biological effects may occur as the result of hypoproteinemia. Hypoproteinemia, resulting in gastrointestinal edema, retards gastrointestinal motility. The edema may cause such retardation of emptying of the stomach at the site of a new anastomosis as to mimic in every way a technical defect of the operation. It also increases the period of delay in wound healing and thus may be a factor in wound disruption. It is important that the labile stores of protein in the body be maintained. An adequate amount of protein in the diet prior to operation will reduce the incidence of injury to the liver following the use of volatile anesthetics. The susceptibility of the liver to injury may be profoundly influenced by diet. Adequate protein in the diet is important in conditioning the liver for minimal injury. The parenteral administration of amino-acids has not corrected hypoproteinemia in our cases. The importance of gastrointestinal feeding in the presence of nutritional deficiency will be pointed out.

Fluid and Nutrition Maintenance by the Use of an Intestinal Tube

W. Osler Abbott, M.D. (by invitation). For the average surgical patient the problem of preserving the fluid and electrolyte balance is relatively simple. The cases of chronic gastrointestinal disease requiring operative relief are more difficult to manage because of the starvation which is often present, not only for a variable time before operation, but often for some days thereafter. While this can be remedied to a degree by parenterally administered solutions we believe that in the presence of pyloric obstruction, jejunal feeding is often preferable. We have, therefore, used a double lumened tube passed through the newly formed stroma. One lumen is used for keeping the stomach empty, the other for the intra-intestinal administration of food. In conditions leading to obstruction further down the tract a long intestinal tube, by emptying the gut contents down to lesion, allows the oral administration of a balanced fluid, electrolyte and fluid intake.

Parenteral Protein Replacement with Amino-Acids

Robert Elman, M.D. Various types of patients suffering protein deficiency and unable to ingest sufficient protein nourishment by mouth have been treated by the intravenous injection of fluid containing electrolyte, glucose, and amino-acids. The amino-acids were obtained by the enzymatic hydrolysis of casein. Nitrogen balance has been achieved with regularity indicating utilization of the injected nitrogen. Evidence of serum albumin regeneration has also been noted in a few cases. Improvement in the general

clinical picture has also been observed. A few of the problems involved in intravenous protein alimentation by this method have been discussed.

The Relation of Proper Preparation of Solutions for Intravenous Therapy to Allergic and Fever Reactions

Carl W. Walter, M.D. (by invitation). Hospitals responsible for the maintenance of a major operating room are capable of preparing a safe supply of parenteral fluids economically. A technic insuring chemical purity of the product as it flows from the injecting needle is the only essential for success. This involves a source of freshly distilled water having a maximum volume conductivity (20° C) of 2.0 X 10-6 mhos, a supply of chemically pure electrolytes and dextrose, an easy method of mechanically cleansing the inner surface of glassware, tubing and needles, and simple apparatus for mixing, sterilizing, storing and dispensing the fluids. Confusion of the meaning of the terms "chemically pure" and "sterile" most frequently accounts for failure. A standardized technic, proven practical and safe in 250 hospitals, will be demonstrated.

The Question of Drainage Following Cholecystectomy

Irvin Abell, M.D., and (by invitation) Irvin Abell, Jr., M.D. At present a review of a series of 500 consecutive operations is being made with an idea of determining what, in our practice, has constituted the indications for the employment of drainage and for the cases in which no drainage has been employed.

Physiological Factors Regulating the Level of the Plasma Prothrombin

Jonathan E. Rhoads, M.D., by invitation of Walter E. Lee, M.D. The rapid purification and synthesis of vitamin K and certain chemical substances with vitamin K activity have made it possible to test the limits of the effectiveness of vitamin therapy in combating prothrombin deficiency. The results obtained with several of these substances will be presented. In this series about 15 per cent of the patients failed to respond to substances with K activity. It has been possible to show that liver damage per se can cause prothrombin deficiency and that in the experimental animal it is much easier to produce prothrombin deficiency by liver damage than by bile salt deprivation. Furthermore, such liver damage acts directly and not merely through interference with bile salt formation. This type of prothrombin deficiency in animals responds poorly or not at all to vitamin K. From this it has been predicted that failure of patients to respond to vitamin K therapy implies severe liver damage. Clinical evidence and autopsy material will be presented to show that this is actually the case. The management of prothrombin deficiencies that do not respond to vitamin K therapy by measures planned primarily to restore liver function will be discussed.

Cholecystitis and Cholelithiasis Produced Experimentally by the Reflux of Pancreatic Secretion

J. Dewey Bisgard, M.D., and (by invitation) Charles P. Baker, M.D. I have recently completed a series of studies in which I have produced acute and chronic cholecystitis and also bile pigment stones in experimental animals by causing pancreatic secretions to enter the gall bladder. This has been produced by a mechanism which is not only possible but also probable in man. I believe, therefore, that I have strong evidence in favor

of the theory of reflux of pancreatic secretions as an important etiological factor in the production of gall bladder disease. To my knowledge this is the first time that stones have been produced in experimental animals by the method of reflux. The work differs from that of Wolfer and others in that the reflux has been produced in a manner which is physiological and which could easily occur in man. I also have chemical and bacteriological studies of the gall bladder bile and histological studies of the gall bladder, liver, pancreas and kidneys. This experimental data is supported by observation of the presence of the pancreatic ferments in the gall bladder of a few patients with acute cholecystitis and other pertinent evidence.

Ileostomy

Henry W. Cave, M.D., and (by invitation) Wm. F. Nickel, Jr., M.D. Surgical measures are being successfully carried out in an increasing number of patients suffering from intractable ulcerative colitis. As curative procedures appendecostomy, cecostomy and colostomy have proven of no value. Ileostomy alone in some instances has proven curative in certain stages of the disease. Questionnaires sent to various surgeons have resulted in obtaining interesting information. As the first stage of total colectomy it is invaluable in approximately 85 per cent of the patients operated upon. The type of ileostomy which has proven successful in our hands will be discussed. A detailed account of the care of ileostomy will be given. Many of these desperately ill patients when first seen are not good surgical risks even for ileostomy. Preoperative preparation will be discussed. In the acute fulminating, rapidly fatal form of the disease early deviation of the fecal stream by means of a double-barrelled ileostomy might prove advantageous. The technical pitfalls will be discussed.

The Diagnosis and Surgical Management of Leiomyomas and Leiomyosarcomas of the Stomach

Frank H. Lahey, M.D. Because of the fact that leiomyomas occur as localized encapsulated growths tending to project into the gastric cavity, they are apt to become ulcerated at their point of maximal projection. This not infrequently results in serious hematemesis. Because of these hemorrhages and the fact that the tumors cause digestive symptoms, these patients are often treated for peptic ulcer. Adequate x-ray examination readily reveals these lesions. From their tendency at first to be local and encapsulated, their diagnosis is not difficult. Exclusive of hemorrhage in the leiomyomas with ulceration or central necrosis, they are chiefly dangerous because they are prone to sarcomatous degeneration. In certain cases, as will be shown by removed specimens and roentgenograms, it is possible to state with certainty that the lesion is benign. In others, as will be shown by specimens and roentgenograms, it is possible to state that the lesion is definitely sarcomatous, but in an intermediate group it is impossible to settle preoperatively whether or not the lesion is sarcomatous. Of six patients with leiomyomas four showed sarcomatous degeneration. Because of this danger, all leiomyomas of the stomach should be removed by subtotal gastrectomy in order to be certain that an adequate amount of stomach is removed should the pathological report prove to be sarcoma. These lesions have occurred as single leiomyomas, as single leiomyosarcomas and as multiple leiomyosarcomas involving the entire stomach. The patients have been treated surgically by subtotal gastrectomy and by total gastrectomy. There has been no mortality and a follow-up of the cases is submitted.

Abdominal Neoplasms of Neurogenic Origin

Henry K. Ransom, M.D. A brief review of the incidence, distribution and pathology of the neurofibromata along with a discussion of their histogenesis and classification. A

group of 16 microscopically verified neurofibromata arising within the abdominal cavity is presented. These tumors may simulate a variety of lesions such as carcinoma of the stomach, colon or rectum as well as pancreatic cysts and retroperitoneal sarcoma. In the later stages, there may be serious complications such as intestinal obstruction, internal fistulae involving the intestine, colon, or bladder, and occasionally the tumors may undergo malignant degeneration. Some of these more unusual abdominal neoplasms which were originally regarded as sarcomas and myxomas have been re-examined and in the light of more recent knowledge, found to belong to the neurofibroma group. Detailed reports of certain illustrative cases are given, together with sketches, roentgenograms, photographs and follow-up notes.

Heparin in the Prevention of Peritoneal Adhesions: Report of Progress

Edwin P. Lehman, M.D., and (by invitation) Floyd Boys, M.D. A preliminary experimental report on the use of heparin in the prevention of intraperitoneal adhesions (Lehman & Boys, Annals of Surgery, March, 1940) presented evidence that heparin introduced into the peritoneum was followed by the reformation of 25 percent of divided adhesions as compared with the reformation of approximately 150 percent of divided adhesions in various control groups. At the time of this report three out of 24 dogs had died of intraperitoneal hemorrhage and this occurrence was presented as a possible deterrent to clinical use of the method. The present report will present data on a series of experiments dealing with the danger of hemorrhage, with dosage and with methods of administration of heparin. Data on the relationship of heparin to contamination of the peritoneum and on the effect on adhesions of general, as opposed to local, heparinization will also be presented.

The Prevention of Ischemic Gangrene following Surgical Operations upon the Major Peripheral Arteries by Chemical Section of the Cervico-dorsal and Lumbar Sympathetics

Idys Mims Gage, M.D., (by invitation) and Alton Ochsner, M.D. The sudden occlusion of a major peripheral artery either by ligature or embolus results in ischemic gangrene, necessitating amputation of an extremity in a rather high percentage of cases. A comparison of the incidence of gangrene following surgical treatment of aneurisms, gunshot and stab wounds, and emboli of the major peripheral arteries is presented and discussed. The prevention of ischemic gangrene by preoperative development and postoperative maintenance of an adequate collateral circulation by chemical section of the regional sympathetics is advocated in all surgical operations upon the major peripheral arteries.

Experimental Studies on the Occlusion of Large Arteries

Herman E. Pearse, M.D. There has never been a satisfactory method devised for the gradual occlusion of the great vessels. The original attempts to solve the problem were carried out by clamps, snares or bands placed on the outside of the artery. The constant force of the pulse against these occluding devices caused pressure atrophy and even rupture of the wall. It appears that any method dependent upon external pressure is dangerous. Several years ago attempts were made to gradually shut off the vessel by using internal occlusion from thrombosis. This principle is feasible but may be technically difficult in a deep wound because of the need of opening or puncturing the artery. Comment is made on some further studies with the use of this principle. A third method of attack might be to induce scar tissue contracture of the vascular wall

and perivascular tissues. Sclerosing agents, chemical irritants, large amounts of fascia and cellophane have been tested for this purpose. The present report deals with the results of these studies on attempted gradual occlusion of the great vessels by the principle of scar tissue contracture in and about the vessel.

Aneurysm of the Abdominal Aorta: Successful Treatment by Ligation

Daniel C. Elkin, M.D. The abdominal aorta was first ligated by Astley Cooper in 1817. There are recorded some 25 similar operations since that time. Most of these procedures have been carried out for iliac aneurysm. It has been done nine times for aneurysm of the abdominal aorta, but has rarely been successful. Matas' patient survived 17 months and Brooks' three. Both died of conditions unrelated to the disease. The patient here reported was operated upon June 1, 1939, for a large aneurysm of the abdominal aorta at the bifurcation. Partial occlusion was obtained by two ligatures of cotton tape placed just above the aneurysm, which was undoubtedly due to arteriosclerotic changes in the aorta. Calcification of the vessel made the placing of the ligature difficult and hazardous. The patient had no disturbance of circulation of the extremities. The aneurysm is now reduced to a small indurated mass without pulsation and is giving no symptoms. Abdominal pain, which was severe, has disappeared. The patient has returned to his duties as a country preacher and is able to be on his feet a greater part of the day and drives his car. Various methods of ligating the aorta are discussed. The history of previous cases is briefly reviewed with reproductions of illustrations of those of historical interest. Collateral circulation to the extremities after ligation of the aorta is considered.

Cardio-vascular Symptoms Presented by Patients Having Cavernous Hemangiomata and Varicose Veins

Walter E. Lee, M.D., and (by invitation) Norman E. Freeman, M.D. Four patients with cavernous hemangiomata and varicose veins form the basis for the present report. In three of these individuals the reflux of blood into the angiomata produced marked changes in the cardio-vascular physiology. Osteohypertrophy was the predominant feature in two patients. In one individual, a defect in the lymphatic valves was also present which resulted in a chylangioma of the scrotum and thigh. Ligation of communicating veins with defective valves brought about relief of symptoms in three of the patients. This symptom complex was first described by Klippel and Trenaunay in 1900. A similar condition was discussed by Parkes Weber in 1918. Sporadic reports of cases have appeared in the American literature.

Arteriovenous Fistula: Experimental Observations and a Critical Review of Eighteen Clinical Cases

Emile Holman, M.D. Observations made in a number of experimental animals, including three puppies, one puppy acting as a control and two puppies having had an arteriovenous fistula produced between the aorta and vena cava when three months old, and allowed to live for a year thereafter; these observations made upon the increased capacity of the vascular system in the presence of such a fistula, it being a new approach as to whether or not there is an increasing blood volume in the presence of a fistula. We have demonstrated that there is a dilatation of the entire vascular system included in the short circuit, namely, heart, proximal arteries and proximal veins. To fill this increased capacity there must of necessity be an increase in the blood volume as has proved to be the case in these puppies. Other experimental observations have to do with the effect of this increased blood volume on the blood pressure and pulse, and the effect of the size of the fistula upon the subsequent sequence of events. Pertinent observations in the clinical cases, covering these points, will also be reviewed. Variations in the

cardiac size, following the establishment of the arteriovenous fistula will also be covered. In one clinical case we were fortunate enough to have accurate observations over a period of seven years, during which time repeated x-rays showed the gradual development of cardiac decompensation and its complete correction after the closure of a subclavian fistula.

Relative Local Efficiency of Sulfanilamide, Sulfapyridine and Sulfathiozol in Contaminated Wounds

J. Albert Key, M.D., and (by invitation) Charles J. Frankel, M.D. Compound fractures of the ribs are produced in a series of laboratory animals. The wound is swabbed with a virulent culture of staphylococcus aureus. Crystals of one of the above mentioned drugs are implanted in the wound and the wound is sutured. This work is now in progress and it is not possible at this time to state what the conclusions will be. Previous work by Jensen, Johnsrud and Nelson and by one of us has shown that the local implantation of sulfanilamide will prevent infection in most contaminated wounds. This has been proved clinically and experimentally. In the present paper we are merely endeavoring to determine whether or not either of the newer, and apparently most important, additions to this series of drugs is more efficient than sulfanilamide in this respect.

The Rate of Healing of Tendons: An Experimental Study of Tensile Strength

Michael L. Mason, M.D., and (by invitation) Harvey S. Allen, M.D. The flexor carpi ulnaris and extensor carpi radialis tendons in the dog have been divided and immediately sutured and a cast applied. At varying intervals following suture the tendons have been removed and the strength of union tested against a spring scale. It has been found that following an initial drop in tensile strength below the strength of the suture in fresh tendon, that there is a gradual increase in strength of union. This rate of increase, however, is subject to many variable factors, prominent among which is that of function. A study has been made of the effect of various periods of immobilization upon the strength of the tendon at different periods in its healing process. Previous experiments have shown that there is considerable variation histologically between specimens of the same chronological stage in healing. These variations are probably due to technical operative difficulties, differences in activity of the animal after operation, infection, etc., and these factors must be evaluated in drawing any conclusions from tensile strength experiments. The results at present indicate that tendon healing follows the general laws of healing as determined by Carrel, Harvey, and others but that the rate of increase of strength of tendon is more rapid if some function is permitted toward the end of the period of fibroplasia. Certain results also appear to indicate that continuous immobilization beyond a certain period of time is associated with a reduction in tensile strength.

The Effects of Pressure on Tissues: An Experimental Study of the Effects of Temperature of the Survival of Anemic Tissues

Barney Brooks, M.D., and (by invitation) George W. Duncan, M.D. It is generally known that varying degrees of stress and strain exist in normal tissues and that unusual amounts of intermittent or constant pressure applied to tissues produce pathological changes. The effects of different amounts of pressure applied for different lengths of time upon the various tissues of the living animal are not definitely known. The tail of the rat is particularly well adapted for the experimental study of this problem, because the animal may be easily restrained and the tail contains so large a number of different

structures readily subjected to known pressures for measured lengths of time. In a series of experiments it was found that the amount of pressure and the length of time for producing massive necrosis were remarkably constant in healthy animals kept at ordinary room temperature. The pathological changes produced by amounts of pressure or periods of time short of that necessary for massive necrosis were also studied. Epithelial hyperplasia, fibrosing myositis and nerve degeneration were observed. Modification of the temperature of the tissues during periods subjected to pressure was found to be a powerful determinant of the length of time necessary for pressure to produce massive necrosis.

Further Anesthesia Studies with Photoelectric Oxyhemoglobinograph

Frank W. Hartman, M.D., (by invitation) and Roy D. McClure, M.D. Through the work of Kurt Kramer in 1933 and 1934, the measurement of oxyhemoglobin in the circulating blood was first accomplished. The Kramer method involves the isolation of an artery and the direct application of a photoelectric cell. The record is made by a galvonometer on photographic paper. Other investigators have shown that capillary blood may be used to determine oxygen saturation providing the capillary bed is first dilated with heat. The latter observation makes it possible to apply Kramer's principle and determine the oxygen saturation from a fold of skin. New photoelectric cells have been devised along with amplifying apparatus which allows the recording to be made with ink on a moving drum of paper. Prolonged observations with both the Kramer machine and our own apparatus are presented, showing the curves of oxygen saturation as produced by various sedatives and anesthetics in common use. Method of preventing and combating anoxia as well as its clinical measurement is discussed.

Congenital Pyloric Stenosis

D. E. Robertson, M.D. This paper will review the result of about 450 cases of pyloric stenosis that have been treated by surgical operation at the Hospital for Sick Children, Toronto. It will compare the occurrence of these cases with those published where statistics are given as to sex and the relation to primogeniture. A special discussion is given to cases of twins. The technic of the Ramstedt operation is described in detail and moving pictures will be shown of the infants before, during and after operation in a pair of maternal twins.

Gastric Acidity Before and After Operative Procedure with Special Reference to the Role of the Pylorus and Antrum: A Preliminary Report of a Clinical and Experimental Study

Owen H. Wangensteen, M.D., and (by invitation) Richard L. Varco, M.D., Lyle Hay, M.D., Benedict Trach, M.D., and Stewart Walpole, M.D. Since 1906, when Edkins proposed the idea that the pyloric antrum played an important role in the regulation of gastric acidity, this hypothesis has been given wide credence by surgeons in the surgical management of ulcer. Considerable information, both experimental and clinical, is available to throw light upon the matter. Much of the testimony, both experimental and clinical, is in obvious disagreement with other available factual data. This paper essays to appraise critically the existing experimental and clinical literature upon the subject and to report the results of our studies: (1) In experimental animals with different forms of pouches and the influence of histamin and histamin-free preparations upon gastric secretion. (2) Studies of pre- and postoperative gastric acidity in patients

with ulcer after various types of operation. Finally, the results of studies in man on the nature of gastric secretion in man at night or during fasting periods.

The Surgical Management of Carcinoma of the Left Half of the Colon

Howard C. Naffziger, M.D., and (by invitation) H. Glenn Bell, M.D. For this study, 161 cases of carcinoma of the left half of the colon (exclusive of carcinoma of the rectum) were reviewed. In only 74 of these was major surgery performed; the operability in the whole series was, therefore, 46 per cent. In this analysis, attention is directed to the preparation of the patient before operation by general measures as well as by decompression of the bowel. In addition, an attempt is made to evaluate different types of operation by means of the five-year results obtained, and a detailed study of the deaths in the series is included.

The Repair of Inguinal Hernia with Transplantation of the Cord to the Femoral Canal

Wm. F. MacFee, M.D. Exposure of the inguinal canal and excision of the hernial sac are done through the usual incision and in the usual manner. The defect in the transversalis fascia is closed with interrupted sutures. The upper and lower surfaces of the inguinal (Poupart's) ligament are dissected free of fat and fascia and the femoral canal is then laid open by detaching the inguinal ligament from its insertion in the pubic spine and freeing it along the superior pubic ramus until the femoral canal is entered. The cord is then transferred from the inguinal canal to the femoral canal and the inguinal ligament is returned to its original position where it is made fast with silk sutures. The ends of the sutures along the pubic ramus may be left long, rethreaded, and used to approximate the internal oblique muscle, to the inguinal ligament along its line of junction with the structures overlying the superior pubic ramus. The external oblique is closed simply or by imbrication as a second layer over the inguinal canal. The chief advantage of the procedure is that it permits complete closure of the inguinal canal without sacrificing the cord and testicle. Since June, 1937 this operation has been employed in the repair of twenty-five hernias, many of them recurrent or large hernias of unfavorable type. The results appear to justify further trial of the method.

Motor and Sensory Innervation of the Colon and Bladder

James C. White, M.D., and (by invitation) Max Verlot, M.D., and Otto Ehrentheil, M.D. This report comprises the results of two years' investigation of physiological changes in the bladder and colon which follow disease, injury, or operative lesions of the brain, spinal cord, cauda equina, and pelvic nerves. In addition to making cystometrograms, the responses of the colon to distention and its sensation have been investigated by a similar technic. The normal colonmetrogram is very similar to the cystometrogram, except for the greater capacity of the colon. The results obtained in the following conditions will be considered: (1) Brain tumors. (2) Transverse lesions of the spinal cord above the pelvic visceral centers. (3) The destruction of sacral segments, cauda or pelvic nerves. (4) Tabes dorsalis and combined system disease. (5) Observations.

The Problem of Producing Complete and Lasting Sympathetic Denervation of the Upper Extremity by Preganglionic Section

Reginald H. Smithwick, M.D. Because we found the clinical results of postganglionic sympathetic denervation of the upper extremity to be unsatisfactory, and because we

found the results of preganglionic sympathetic denervation of the lower extremity to be satisfactory, we have been trying to develop a technic for preganglionic denervation of the upper extremity. In the past five years, three methods have been employed, first, ramisectomy (D2 and D3) and trunk section below D3. This was found unsatisfactory because it was often incomplete, and "relapse" of consequence due to regeneration frequently followed. Second, extraspinal anterior root section (D2 and D3) and trunk section below D3 was performed. This has always resulted in a denervation which was adequately complete, and in excellent immediate clinical results. In some instances, however, slight to moderate degrees of regeneration with partial return of symptoms has been noted months to years later. Our present technic, intraspinal (intraarachnoid) anterior root section (D2 and D3) and trunk section below D3, gives promise of being a satisfactory solution of the problem.